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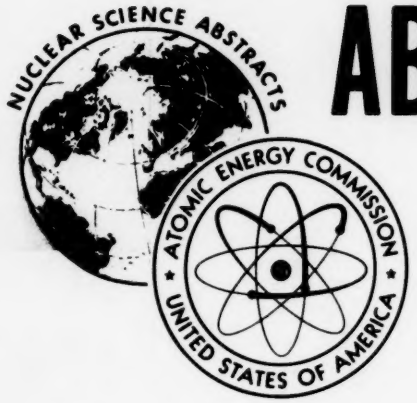

Volume 26 Number 5

Abstracts 8674-11487

March 15, 1972

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Volume 26, Number 5, March 15, 1972

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Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
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NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/81b-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
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separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 9002, 9521, and 9688.

8674 (LFEN-NI,-65-a) EDTA AS EXTRACTANT IN THE ANALYTICAL DETERMINATION OF URANIUM AND OF IRON IN PHASES EXTRACTED BY AMINES. Junior, A. Silva (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 12p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A reextraction method for aqueous solutions using EDTA as the complexant is proposed. The method is fast, easy, and sufficiently exact and precise. The step-by-step procedure is given for determination of U and Fe in the organic and aqueous phases. The errors of the method are discussed. (J.S.R.)

8675 ISOTOPES AND RADIATION TECHNOLOGY. VOLUME 9, NUMBER 2. Baker, P. S.; Lafferty, R. H. Jr.; Gerrard, Martha; (and others) (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Winter 1971-1972). 128p. GPO $0.70.

Eight sections containing 27 papers are included; separate abstracts were prepared for 14. The remaining papers and articles contain information on: instant ^{99m}Tc compounds; food irradiation; new aspects in the field of γ-irradiation plants; Ezeiza semi-industrial irradiation plant; source development; safety features of French cardiac pacemaker fueled with ^{238}Pu; comparative evaluation of power-system types for underseas applications; SNAP-21; and miscellaneous. Many of these articles were previously published in the form of reports, conference papers, etc. (P.C.H.)

For abstracts of individual papers see: 8693, 8761–8763, 8981–8983, 9033, 9083, 9153, 9154, 9406, 9454, and 9455.

8676 MODERN METHODS OF GEOCHEMICAL ANALYSIS. Wainerdi, Richard E.; Uken, Ernst A. (eds.). Monographs in Geoscience. New York; Plenum Publishing Corporation (1971). 314p. $22.50.

The advantages, limitations, and expected sensitivity of various methods for geochemical analysis are discussed. Topics covered include: statistics, chemical analysis and sample preparation, ion-exchange chromatography, colorimetry, infrared spectrometry, optical emission spectroscopy, atomic absorption, x-ray techniques, radiometric techniques, nuclear activation analysis, and mass spectrometry. (275 references). (M.C.G.)

8677 SEPARATION AND CONCENTRATION OF ACETYLACETONATO CHELATES USING A BENZENE COLUMN. Maruyama, Kazuo; Mashima, Micho (Niigata Univ., Nagaoka, Japan). Bull. Chem. Soc. Jap.; 44: No. 8, 2147-9(Aug 1971).

The application of the zone-melting technique to metal chelate compounds is reported. An organic solvent which is liquid at room temperature (such as benzene) and several acetylacetonato and thenoyltrifluoroacetonato chelates as solutes were prepared. The effective distribution coefficient, k, dependence on the molecular weight was revealed by the normal freezing technique. In the deployment process, the acetylacetonato chelates of Fe and Th were chosen as solutes because their k values were different. The experiment was carried out at 2 cm/hr, the rate of zone travel. When a 30-cm column was used, the "removal percentages" of Fe from Th were 41 and 85% for 3 and 5 zone passes, respectively. However, there was a 22% loss of Th in the latter case. Furthermore, a remarkable concentration was found, and it was shown that the concentration effect may be useful for microanalysis. At this stage, a relatively large bubble of benzene was observed at the liquid and solid interface; therefore, we can call this "three-phase zone-melting." (auth)

8678 SORPTION OF MICRO-AMOUNTS OF ^{226}Ra ON THE LUMINOPHORE ZnS(Ag). Stanek, Z.; Mansfeld, A. Radioisotopy; 11: No. 4, 705-14(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

Basic information on the sorption of microamounts of radium-226 on the luminophore ZnS(Ag) was obtained for further use in a quantitative determination of Ra in waste and surface waters. The results obtained showed a maximal sorption of radium-226 in a medium of distilled water, i.e., 6.5% in comparison to 12% attained in the medium of sulfate ions. Nevertheless, these values would be insufficient for an analytical determination of radium-226 in waste and surface waters. For an analytical determination of polonium-210 by sorption on the luminophore ZnS(Ag), an interference of radium-226 as an α-emitter is not to be presumed. Regarding the results obtained with ^{210}Po, the excellent qualities of ZnS(Ag), and the high measuring efficiency of α-emitters, a further verification of this method even for other α-emitters and the global determination of α activity would be of extreme interest. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 9017, 9241, 9427, 9429, and 9445.

8679 (EUR-4714) PRECISE COMPLEXIMETRIC DETERMINATION OF THORIUM. Brueck, A.; Lauer, K. F. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971. 14p. Dep. NTIS (U. S. Sales Only). EUR FF 4.45.

Thorium was determined by complexiметric titration using Xylenol Orange as an indicator. Quantities above 5 mg thorium per determination were analyzed, using visual endpoint detection. The precision and accuracy is better than 0.1%. For quantities less than 5 mg thorium per determination, a photometric endpoint detection is used. (auth)

8680 (GAT-Z-5048) QUANTITATIVE ANALYSIS OF MOLYBDENUM IN A GASEOUS PHASE IN URANIUM HEXAFLUORIDE BY ATOMIC ABSORPTION SPECTROSCOPY. Sassoulas, R.; Serpinet, J. Translated for Goodyear Atomic Corp., Piketon, Ohio, from Spectrochim. Acta; 23B: 227-34(1968). 11p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 12261.

8681 (HEDL-SA-290) PLUTONIUM OXIDE MEASUREMENT STUDIES. Smith, F. M. (Hanford Engineering Development Lab., Richland, Wash.). 10 Sep 1971. 8p. (CONF-711037-1). Dep. NTIS.

From Panel on quantitative data and results of systems analysis and integral tests; Vienna, Austria (4 Oct 1971).

Plutonium assay experiments demonstrated that plutonium oxide

can be measured with a relative standard deviation of 0.3%, or better, under regular production control conditions. The analytical errors appeared to be the largest component of variance with a relative standard deviation of 0.26%. Sampling did not appear to be a major source of error for the well homogenized and protected oxide powder. The dissolution errors appeared to be statistically insignificant for the non-calcined samples and significant for calcined samples. The differences between analyses from the same dissolution and the differences between dissolution pairs tended to be normally distributed. Relative analytical biases in the plutonium results compared with those from two other laboratories could not be discerned with confidence but tendencies toward biases were observed. The largest difference between two laboratories for a single lot of material was observed to be 0.73 relative %. The material balance experiment demonstrated that excellent shipper-receiver net powder weight comparisons can be achieved when the weighing operations are performed under dry atmospheric conditions. (auth)

8682 (NP-19139) COMPUTER PROGRAMS FOR USE IN X-RAY SPECTROGRAPHY: DETERMINATION OF TRACE ELEMENTS AND OF DEAD-TIME OF COUNTERS. Oertel, A. C. (Commonwealth Scientific and Industrial Research Organization, Melbourne (Australia)). 1971. 16p. Dep. NTIS (U. S. Sales Only).

Computer programs for use in x-ray spectrography are described. Two are for determination of trace elements: one where only the analysis line is subject to interference, the other where both analysis line and adjacent background are subject to interference. The third program is for determining the dead-time of counters. (auth)

8683 X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF RARE EARTH ELEMENTS BY USING A FUSION TECHNIQUE. Plowman, C. (Central Electricity Generating Board, Kirkstall, Eng.). Analyst; 96: No. 1148, 776-8(Nov 1971).

A general method for determination of rare earth elements by x-ray fluorescence spectrometry is described. The sample is fused with sodium tetraborate, chromium is added to act as internal control-standard, and the resulting bead is analyzed directly. This method overcomes variations in sample form and particle size. Individual rare earths can be determined at levels from 0.1 to 100%, and by using the L spectra and a lithium fluoride 220 crystal, line overlap is kept to a minimum. (auth)

8684 DETERMINATION OF 0.01 TO 0.1 PERCENT OF SAMARIUM IN 40 TO 100 mg OF LEAD CHLORIDE. Agterdenbos, J.; Juette, B. A. H. G.; Schuring, J. (State Univ., Utrecht). Talanta; 18: No. 10, 1074-6(Oct 1971).

A method is described for the determination of 5 to 25 μg of samarium in about 40 mg of lead chloride, based on the removal of the lead by electrolysis and determination of the samarium by extraction using 1-(2-pyridylazo)-2-naphthol (PAN) and measurement of the extinction of the complex at 552 nm. (auth)

8685 INCREASING THE SENSITIVITY AND SELECTIVITY OF THE REACTION OF GALLIUM WITH PYROCATECHOL VIOLET IN THE PRESENCE OF DIPHENYLGUANIDINE. Akhmedli, M. K.; Glushchenko, E. L.; Gasanova, Z. L. (Azerbaydzhan State Univ., Baku). Zh. Anal. Khim.; 26: No. 10, 1947-52(Oct 1971). In Russian).

A three-component complex Ga–pyrocatechol violet–diphenylguanidine at a ratio of 1:3:3 is formed. The color develops immediately and is stable not less than a month. The complex is extracted with alcohols and chloroform. Complete extraction is achieved by a single-time procedure (E = 99.5%). The molar extinction coefficient and the strength of the three-component compound ($\epsilon_{600} = 1.08 \cdot 10^5$, $K_{inst} = 1.83 \cdot 10^{-26}$) are considerably higher as compared with a two-component one ($\epsilon_{580} = 7.3 \cdot 10^4$, $K_{inst} = 0.9 \cdot 10^{-17}$). This makes the reactions much more sensitive and selective. From 1 to 8 μg of Ga can be determined in 10 ml of the extract with a relative error of 2.4%. When metallic aluminum is analyzed the separation of the base is necessary; the error is 3 to 4% relative. (auth)

8686 EFFECT OF ADDITION OF CERTAIN SUBSTANCES DURING THE SPECTROGRAPHIC DETERMINATION OF TUNGSTEN AND MOLYBDENUM BASED ON GRAPHITE POWDER. Tarasevich, N. I.; Khlysova, A. D.; Shuvalova, E. I. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 10, 1958-61(Oct 1971). (In Russian).

A study was made of the effects of KCl, NaCl, CsCl, CuCl, $CuCl_2$, $PbCl_2$, and AgCl on the intensity of spectral lines of tungsten and molybdenum in the dc and ac arc. The most effective additive under the conditions existing is $PbCl_2$. The thermodynamic isobaric potential for the supposed chlorination reaction between tungsten, molybdenum, and the above additives was calculated. The sensitivity of the spectrographic determination of tungsten and molybdenum using as a base graphite powder and $PbCl_2$ (1:1) was obtained as 1×10^{-3} and 5×10^{-5}%, respectively. The variation coefficients are 4% for determining 3×10^{-3}% of W and 12% for determining 1×10^{-4}% of Mo. The method can be recommended for determining tungsten and molybdenum in concentrates based on graphite powder. (auth)

8687 PHOTOMETRIC DETERMINATION OF TUNGSTEN(VI) IN THE PRESENCE OF LARGE AMOUNTS OF MOLYBDENUM(VI) BY MEANS OF PYROCATECHOL VIOLET. Lebedeva, L. I.; Golubtsova, Z. G.; Yanklovich, N. G. (Leningrad State Univ.). Zh. Anal. Khim.; 26: No. 10, 1962-6(Oct 1971). (In Russian).

A modification of the photometric determination of tungsten in the presence of large amounts of molybdenum by means of pyrocatechol violet (PCV) was developed. The interaction in the system Mo–PCV was studied. It was established that a complex compound Mo:PCV = 2:1 is formed. The possibility of forming a three-component compound in the system Mo–hydroxylamine–PCV was shown spectrophotometrically, as well as the interaction between tungsten and molybdenum in the presence of hydroxylamine and PCV. A method was found for taking into account this interaction under the conditions of analytical determination of tungsten with PCV in the presence of large amounts of molybdenum. (auth)

8688 ANALYTICAL APPLICATION OF THE COMPOUND OF THE URANYL BENZOIC ACID COMPLEX WITH BRILLIANT GREEN. Kovalenko, P. N.; Shchemeleva, G. G.; Stepanenko, Yu. V. (Rostov-on-Don State Univ., USSR). Zh. Anal. Khim.; 26: No. 10, 1979-83(Oct 1971). (In Russian).

The reaction of uranium(VI) with brilliant green in the presence of sodium benzoate was studied. In a weakly acid medium (pH 4.55 to 5.00) a green compound is formed that is sparingly soluble in water. The compound can be extracted with toluene. Uranium, benzoate, and brilliant green form the compound at a ratio of 1:3:1. The molar extinction coefficient of toluene extracts of the three-component compound with maximum absorption at 640 nm is 9.34×10^4. On the basis of the reaction studied the procedure of the extraction-photometric determination of uranium in mining waters was developed. (auth)

8689 SPECTROPHOTOMETRIC DETERMINATION OF LANTHANIDES USING ERIOCHROME CYANINE R.C. Munshi, K. N. (Nagpur Univ., India); Dey, A. K. Chim. Anal. (Paris): 53: No. 8, 539-42(Aug 1971). (In French).

The color reaction of sulfohydroxy dimethyl fuchsone dicarboxylic acid (Eriochrome Cyanine RC) with rare earth metals was studied using spectrophotometry in order to determine the very small quantities of rare earth present. At a pH of 6.5, the complexes present absorbance curves with the following values of λ max: 490mμ (Ce, Pr), 500mμ (Nd), 510mμ (Sm), 520mμ (Eu, Gd, Tb, Dy, and Ho), 530mμ (Er, Tm, Yb, and Lu). High wavelengths, where the absorbance of the reagent is very small, were considered. The optimum conditions for determining the quantity of rare earth metals present, using this reagent, were studied, the following considerations being taken into account: the effect of pH on the absorbance of the chelate, the effect of reagent concentration, the limits to conformity with Beer's law, photometric measurements, the molar absorption coefficient, the rate of color formation and color stability at room temperature. (France)

8690 OPTICAL SPECTROGRAPHIC DETERMINATION OF TRACE ELEMENTS IN Pu AND U AFTER SOLUBILIZATION AND SEPARATION OF THE MAJOR CONSTITUENT. Le Clainche, C. (Centre d'Etudes de Bruyeres-Le-Chatel, Montrouge, France). Method. Phys. Anal.; 7: No. 2, 115-23(Jun 1971). (In French).

The elements to be analyzed were separated from the matrix. A liquid–liquid separation between TBP and a 7M nitric acid solution is used. The nitric phase containing the main impurities is collected; a 50 μg/ml palladium solution is added. After concentration, 0.1 ml of the solution is dried on the flat top of a graphite electrode. A direct current of 10 amp is used for 20s. Calibration curves are presented and the results obtained discussed. (France)

8691 QUANTITATIVE ANALYSIS OF HYDROGEN ISOTOPES BY MASS SPECTROMETRY. Schott, R.; Beau, G. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Method. Phys. Anal.; 7: No. 2, 165-9(Jun 1971). (In French).

In order to separate the doublet HD–^{3}He at mass 3, and the doublet HT–D_2 at mass 4, a slit changing device allowing resolution power of 1000 was used. On the other hand, a mass-selector was used which reduces the scanning-times between two masses. Preferential diffusion on the light isotope must be avoided. (France)

8692 USE OF KING FURNACE IN ATOMIC ABSORPTION SPECTROMETRY. ANALYSIS OF TRACE ELEMENTS IN U. Buffereau, M.; Robichet, J. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Method. Phys. Anal.; 7: No. 2, 138-45(Jun 1971). (In French).

General conditions were studied for the use of the King furnace with atomic absorption spectrometry. The effects of parameters such as argon flow, graphite, anions, and U matrix were investigated. Measurement limits are given for about twenty elements. (France)

8693 ENERGY-DISPERSION X-RAY (EDX) ANALYSIS IN THE NONFERROUS MINING INDUSTRY. Langheinrich, A. P.; Forster, J. W.; Linn, T. A. Jr. (Kennecott Copper Corp., Salt Lake City). Isotop. Radiat. Technol.; 9: No. 2, 173-81 (Winter 1971-1972).

Energy-dispersion x-ray (EDX) spectrometry based on Si(Li) detectors is approximately 5 years old. Although its first application in the mineral industries was reported in 1967, it is only now being accepted for its unique capabilities and considered competitive with other analytical techniques. Energy-dispersion x-ray equipment in combination with radioisotope sources was used successfully in the analysis of mining and milling samples for Cu, Fe, Mo, Pb, Zn, and U. Sample types included solids, solutions, muds, and slurries. A variety of modular combinations of sources, sample cells, Si(Li) detectors, amplifiers, single- and multichannel analyzers, scalers, rate meters, printers, and recorders was used to fit particular jobs. Test results and field applications have demonstrated the value of EDX instrumentation as an analytical tool. Its future wide use in laboratory, pilot plant, and process plant is expected. (auth)

8694 SPECTROCHEMICAL DETERMINATION OF RARE EARTH METALS IN URANIUM AND ITS SALTS. Zmbova, B. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade); Tripkovic, M.; Secerov, O. Talanta; 18: No. 11, 1117-21(Nov 1971).

An emission spectrographic procedure is described for determination of 0.05 to 4 ppM of rare earth metals in uranium metal and its salts. Uranium is extracted from the sample with tributyl phosphate, and the impurities are separated by precipitation as hydroxides and oxalates, with yttrium as a carrier. After conversion into the oxides, the rare earth metals are mixed with graphite and excited in a dc arc. (auth)

8695 PREPARATION OF REFERENCE SAMPLES FOR URANIUM IN LOW GRADE ORES. Pure Appl. Chem.; 27: No. 1-2, 291-304(1971).

An appraisal is given of the analytical chemistry of U in primary and secondary ores in concentrations of tenths of 1%, and a description is given of the preparation of reference samples of certain low-grade ores (torbenites, carnotites, and uraninites). The primary objective was to establish, by international comparative collaboration in various laboratories, the best value for the U content of the samples, so that the material could be used for checking chemical procedures for U determination in such ores. Details are given of sample decomposition, together with appraisals of the determination of U by various methods, including spectrophotometric (by the thiocyanate, dibenzoylmethane, arsenazo, and thioglycollic methods), fluorimetric, and titrimetric. A method based on 2-(2-pyridylazo)-5-diethylaminophenol is mentioned. (13 references) (UK)

8696 TRACE AND MAJOR ELEMENT CONTENTS OF SOIL SATURATION EXTRACTS. Bradford, G. R.; Bair, F. L.; Hunsaker, V. (Univ. of California, Riverside). Soil Sci.; 112: No. 4, 225-30(Oct 1971).

Using a spectrochemical procedure, sixty-eight soil samples, representative of thirty soil series in California, were characterized by analyses of the saturation extracts for trace and major elements including Mo and Sr. The soils were analyzed also for exchangeable calcium, magnesium, sodium, and potassium, and for available phosphorus. The usefulness of the resulting type of data was illustrated by comparison of it to similar data obtained from a variety of experiments related to other problems of current interest: (a) molybdenum accumulation in forage feeds for dairy animals; (b) manganese accumulation in strawberry plants; (c) nickel toxicity from serpentine minerals; (d) heavy metal pollution from freeway dust and underwater sediments subject to industrial pollution; and (e) temperature effects on mineral element solubility in several soils. (auth)

8697 SPECTROGRAPHIC DETERMINATION OF MICROGRAM AMOUNTS OF YTTRIUM AND SOME RARE EARTHS IN URANIUM OXIDES. Butucelea, A.; Craiu, Margareta (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 16: No. 9, 1287-90(Sep 1971).

The elements Y, Eu, Sm, Gd, and Dy were separated from the uranium oxide matrix by using tri-n-octylamine on silica gel in a chromatographic column. The elements were determined spectrographically in a dc arc, using NaCl as distillation carrier. The lower limits of quantitative detection lie between 0.12 and 0.45 ppM for each element. (auth)

8698 AMPEROMETRIC COMPLEX-FORMATION TITRATION OF TRACES OF THORIUM. Freese, F.; Oostervink, R.; den Boef, G. (Univ., Amsterdam). Talanta; 18: No. 10, 1064-6(Oct 1971).

Thorium was determined in the microgram range by complexometric titration with EDTA. The end-point was detected by following the anodic wave of EDTA at a rotating mercury electrode. It was found that thorium can be titrated in the presence of large amounts of other metals. Following electrolysis at a mercury pool electrode the titration is selective for thorium. (auth)

8699 PYRIDINE KETOXIMES AS ANALYTICAL REAGENTS: THE SPECTROPHOTOMETRIC DETERMINATION OF GOLD WITH 2,2′-DIPYRIDYL-α-GLYOXIME. Soules, D.; Holland, W. J. (Univ. of Windsor, Ont.). Mikrochim. Acta; No. 4, 565-8(1971).

A spectrophotometric method is described for the determination of gold with 2,2′-dipyridyl-α-glyoxime. Effects of pH, solvents, reagent concentration, time, heating, ion-pair formation, and diverse ions, including UO_2^{2+} and Th^{4+}, are reported. Beer's law is obeyed and the molar absorption coefficient is 1.7×10^4 l $M^{-1} \cdot cm^{-1}$ at 448 nm. (auth)

8700 MODIFIED SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF TRACES OF BORON USING QUINALIZARIN IN A SULFURIC-ACETIC ACID MEDIUM. Gupta, H. K. L.; Boltz, D. F. (Wayne State Univ., Detroit). Mikrochim. Acta; No. 4, 577-81(1971).

A modified spectrophotometric method for the determination of boron with quinalizarin in a sulfuric–acetic acid medium is proposed. The sensitivity of the method is 0.00037 $\mu g/cm^2$. The optimum concentration range is 0.06 to 0.25 ppM of boron. The effects of 39 diverse ions, including thorium and uranyl, are reported. (auth)

8701 FURTHER DEVELOPMENT OF THE ANALYTICAL PROCESS FOR MILLIGRAM AMOUNTS OF ISOLATED STRUCTURAL COMPONENTS. Koch, W.; Bosch, H. (August Thyssen-Huette AG, Duisburg, Ger.). Mikrochim. Acta; No. 4, 593-605 (1971). (In German).

A combination of highly sensitive procedures of atom absorptions, Roentgen fluorescence, and photometry is suggested for the analysis without separations of steel during research and process control. Analytical procedures are given for 29 elements, including Mo, Zr, Ce, La, Nd, Pr, and Nb. The variation coefficients in the optimal measuring range are approximately 2%. (auth)

8702 OXIDATION OF AROMATIC AMINES. II. COLOR REACTIONS FOR AMINES. Stamatova, V. T.; Manolov, K. R. Mikrochim. Acta; No. 4, 606-9(1971). (In German).

The oxidation of aromatic amines with hydrogen peroxide in the presence of various metal ions, including thorium and uranyl, after acidifying with various acids yields various colored products and is suitable for detection of amines. The identification limits of several color reactions are given. (auth)

8703 RAPID SEMI-AUTOMATIC DETERMINATION OF CHLORINE, BROMINE, AND IODINE IN ORGANIC SUBSTANCES. Calme, P.; Keyser, M. (CNRS, Strasbourg). Mikrochim. Acta; No. 4, 644-56(1971). (In French).

A semi-automatic recording microanalyzer for chlorine, bromine, and iodine based upon the reaction of halogen and halohydric gases on ozonized silver iodide is described. The liberated iodine is absorbed in a buffered solution of NaI and automatically titrated by sodium thiosulfate. This method is convenient for use with substances containing large or small amounts of halogens and particularly for high polymers. (auth)

8704 NEW SPOT TESTS FOR VANADIUM(IV), SILVER, AND MOLYBDENUM. Rao, N. Venkateswara; Eswara Dutt, V. V. S.; Suryanarayana, M.; Prasad, J. (Andhra Univ., Waltair, India). Mikrochim. Acta; No. 4, 667-74(1971).

New spot tests for vanadium(IV), silver, and molybdenum are described. Vanadium(IV) can be detected by treating Erioglaucine A and Eriogreen B, or Ponceau 2 R and Chromotrope 2 R with sodium hydroxide and one drop of the test solution. The color of the dye solution is discharged immediately. The spot test for silver is based on its catalytic influence on the reaction between hypophosphite and permanganate, dichromate, or vanadate. The method consists of treating sodium hypophosphite solution with

dilute sulfuric, nitric, or perchloric acid, 1.0 ml of 0.1 N permanganate and 1 drop of silver nitrate solution and diluting the mixture to 5 ml. The pink color of permanganate solution will be discharged in about 5 minutes. Using dichromate or vanadate, the color changes are brought about in 4 and 5 minutes, respectively. The photochemical reduction of molybdenum(VI) to molybdenum(V) and the formation of a red colored complex between molybdenum(V) and thiocyanate is utilized for the spot detection of molybdenum. When a mixture of molybdate, hydrochloric acid, hydrazine sulfate, and thiocyanate is exposed to light from a Philips "Repro" lamp, an orange color appears in 3 minutes. Hydrazine sulfate exerts a synergistic effect in this reaction. (auth)

8705 SPECTROPHOTOMETRIC DETERMINATION OF EUROPIUM(III) USING CHROME AZUROL S. Cattrall, R. W.; Slater, S. J. E. (La Trobe Univ., Bundoora, Australia). Microchem. J.; 16: No. 4, 602-9(Dec 1971).

Europium(III) can be conveniently determined using Chrome Azurol S. The stoichiometry of the complex formed and a range of interferences are discussed. Of the cations tested, Mo(VI) and W(VI) produced no interference whereas Sc, Y, La, Sm, Gd, Tb, Dy, Ho, Yb, Zr(IV), Th(IV), Al, Cu, Be, UO_2(II), Fe(II), and Fe(III) ions led to positive errors in the determination. (J.G.B.)

8706 ISOTOPE-EXCITED X-RAY FLUORESCENCE ANALYSES FOR Nb, Zr, AND La + Ce ON OUTCROPS IN THE ILIMAUSSAQ INTRUSION, SOUTH GREENLAND. Wollenberg, Harold (Danish Atomic Energy Commission, Risoe); Kunzendorf, Helmar; Rose-Hansen, John. Econ. Geol.; 66: No. 7, 1048-60(Nov 1971).

A portable isotope-excited x-ray fluorescence system, incorporating balanced filters, was tested on outcrops of rare-element-bearing Precambrian alkaline rocks of the Ilímaussaq intrusion, S. Greenland. Mineralizations examined included sheared lavas and dikes containing disseminated murmanite, peralkaline syenites-naujaite, kakortokite, and lujavrite containing one or more of the minerals, eudialyte, monazite, steenstrupine, and rinkite, and hydrothermal veins with pyrochlore and lueshite (igdloite). Calibration curves for Zr, Nb, and La + Ce were obtained from regression analyses of field count rates versus wet chemical, mass spectrometric, and x-ray spectrographic assays of chip samples and sawed rock slabs. Detection limits, based on the regression analyses' 95% confidence intervals, were 0.44% for Zr, 0.15% for Nb, and 0.17% for La + Ce. Precision, estimated from difference count rates, was less than 15% (relative error) for Zr and Nb, and between 15 and 30% for La + Ce. Accuracy, based on the regression analyses, was about 0.15% for the elements measured. Traverses across terranes containing varying amounts of these elements showed that the system detects and analyses disseminated mineralizations of possible economic value. Zr contents ranged from below the detection limit in steenstrupine lujavrites and analcime veins to 4.7% in eudialyte-rich kakortokite, Nb varied from below the detection limit in steenstrupine lujavrites and white and black kakortokites to 0.51% in pyrochlore-bearing analcime veins, and La + Ce from 0.24% in black kakortokite to 1.21% in steenstrupine-rich fine-grained lujavrite. (auth)

8707 3,6-PYRIDAZINEDIOL AS A SPECIFIC SPECTROPHOTOMETRIC REAGENT FOR THE DETERMINATION OF IRON. Hashmi, M. H.; Qureshi, Tehseen; Ajmal, A. I. (Pakistan Council of Scientific and Industrial Research Labs., Lahore). Microchem. J.; 16: No. 4, 626-32(Dec 1971).

Iron(III) reacts with 3,6-pyridazinediol in the presence of nitric acid to give a pink color having maxima at 480 mμ. The color reaction which is specific for iron (III), has 1 μg/ml as the visual limit of identification and provides the basis of a new spectrophotometric method for the determination of iron. The quantitative assessment of the tolerable amount of various ions that do not interfere with the determination including Th^{4+} and U^{6+}, are reported. The mechanism of the color reaction is not clear. (auth)

8708 CHELATOMETRIC DETERMINATION OF NIOBIUM IN HIGH TEMPERATURE ALLOYS AND STAINLESS STEEL USING 4-METHYL DAPHNETIN AS A PRECIPITANT. Mizuno, Kingo (Iron and Steel Technical Coll., Amagasaki, Japan). Jap. Anal.; 20: No. 7, 806-12(Jul 1971). (In Japanese).

A chelatometric method for determining niobium in alloys and stainless steel using 4-methyl daphnetin (7,8-dihydroxy-4-methylcoumarin) as precipitant is presented. Titanium and tin interfere. In the presence of these elements in high concentrations an addition of pyrocathechol using aqueous ammonia as neutralizing solution is necessary before addition of the precipitant. (D.H.M.)

8709 STUDIES ON ANALYSIS OF RARE EARTHS. IV. ATOMIC ABSORPTION SPECTROMETRIC DETERMINATION OF EUROPIUM. Sato, Matsuji; Matsui, Hiroshi; Matsubara, Tadao (Shin-Etsu Chemical Industry Co., Ltd., Takefu, Japan). Jap. Anal.; 20: No. 7, 856-61(Jul 1971). (In Japanese).

An atomic absorption spectrometric study was carried out to establish fundamental conditions in the determination of europium in mixed rare earth oxides. Absorption by europium was measured at 4594 Å by use of an air–acetylene or a nitrous oxide–acetylene flame. An enhancement in the absorption of europium was given by co-existent rare earths irrespective of their atomic number. Constant values were attained by the presence of large amounts of lighter rare earths, while the effect of heavier rare earths depended upon their atomic numbers. The addition of alkali elements — lithium, sodium, or potassium as their chlorides — resulted in an enhancement in the absorption of europium and the effect was more significant as the ionization potential of the alkali element became lower. A noticeable improvement was achieved in the analytical sensitivity of europium by an addition of 1 g/l of KCl. The lower limit for the determination of europium was 10 ppM and the coefficient of variation was 2.4% at 100 ppM level of europium in mixed rare earth oxides. (auth)

8710 SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTHS IN STEEL AFTER SEPARATION BY EXTRACTION WITH HIGH-MOLECULAR-WEIGHT QUATERNARY AMMONIUM SALT. Okamoto, Kazuhiko; Tominaga, Takehiko (Kwansei-Gakuin Univ., Nishinomiya, Japan). Jap. Anal.; 20: No. 7, 870-8(Jul 1971). (In Japanese).

For the photometric determination of the total rare earths and the individual components with Arsenazo I, solvent extraction of the rare earths and paper chromatographic separation of individual elements were studied by using a high-molecular-weight quaternary ammonium salt. Rare earths (La, Ce, Pr, Nd, and Sm) were extracted with 30 vol % Moonion A-9Q-08 (Methylbenzyldialkylammonium nitrate)–xylene solution from 7M sodium nitrate solution, but other elements present in common steel were not extracted except for molybdenum(VI) and vanadium(V). The extracted rare earths were back-extracted into 6M hydrochloric acid, and molybdenum(VI) and vanadium(V) remained in the organic phase. Cerium(IV) was extracted with 30 vol % Moonion A-9Q-08–benzene solution from 7M nitric acid–1M sodium bromate solution, and was separated from other rare earth elements. Lanthanum, praseodymium, neodymium, and samarium were separated from each other by the reversed-phase paper chromatography with a filter paper impregnated with Moonion A-9Q-08 by using 3M sodium nitrate solution as the developer. The difference of R_f values of two adjacent elements was about 0.2. After their separations, the total rare earths and the individual components could be determined photometrically with Arsenazo I. The results of the analysis of the samples containing 0.03 to 0.05% of rare earths were satisfactory. (auth)

8711 SPECTROPHOTOMETRIC DETERMINATION OF ANIONS BY SOLVENT EXTRACTION WITH METAL CHELATE CATIONS. XIV. DETERMINATION OF IODIDE IONS WITH TRIS(1,10-PHENANTHROLINE)IRON(II). Yamamoto, Yuroku; Tarumoto, Tsunehiko; Tsubouchi, Masahiro (Hiroshima Univ.). Bull. Chem. Soc. Jap.; 44: No. 8, 2124-6(Aug 1971).

Iodide was extracted from the aqueous phase into nitrobenzene in a pH range of 3 to 9 by use of tris(1,10-phenanthroline)iron(II) chelate cations and then determined spectrophotometrically at 516 mμ. Beer's law was effective up to 8.0×10^{-5} M of iodide in the aqueous phase. Standard deviation of the determination was 1.1% at 15°C. The color intensity of the extracted species in nitrobenzene was constant for at least 3 hr. The distribution ratio was 1.02 at 15°C and 0.83 at 26°C. No serious interferences by foreign anions were observed except for perchlorate, chlorate, and thiocyanate. Cations did not essentially interfere with the determination. (auth)

8712 SPECTROPHOTOMETRIC DETERMINATION OF PYROPHOSPHATE WITH TRANS-DICHLORO-BIS(ETHYLENEDIAMINE)COBALT(III). Sharma, Chokhe Lal (Univ. of Roorkee, India). Indian J. Chem.; 9: No. 3, 279(Mar 1971).

Pyrophosphate in aqueous medium gives a violet color (stable for 24 hr) with trans-dichloro-bis(ethylenediamine)Co(III) having maximum absorbance at 510 m. On the basis of this reaction, a spectrophotometric method is proposed for the estimation of pyrophosphate in the concentration range 40 to 950 ppM. The mean sensitivity is 20 $\mu g/cm^2/0.005$ absorbance unit. A number of foreign ions including ortho- and meta-phosphates do not interfere even if present in excess while traces of Cu^{2+}, VO_2^{2+}, MoO_4^{2-}, Ce^{4+}, Th^4, and Mg^{2+} interfere in the estimation of pyrophosphate. (auth)

8713 AMPEROMETRIC TITRATION OF METAL IONS WITH EDTA. INDICATION OF EDTA EXCESS BY ADDITION OF LEAD(II)–EDTA, MANGANESE(II)–EDTA, OR THALLIUM(I)–

EDTA. Kainz, Gerard; Meisinger, Friedrich; Sontag, Gerhard (Univ., Vienna). Mikrochim. Acta; No. 4, 630-8(1971). (In German).

The equivalence point in titrations of metal ions with EDTA can be indicated amperometrically, if small amounts of Pb^{2+}–EDTA, Mn^{2+}–EDTA, or Tl^{+}–EDTA are added. This method is performed with two platinum electrodes; a voltage of 1.2 V is applied to these electrodes. It was stated that the platinum anode is covered with a fine layer of PbO_2, MnO_2 or Tl_2O_3. When an excess of EDTA is used, this oxide film causes an increase of current between the platinum electrodes. The additions of metal chelates are effective only within defined pH ranges: Pb^{2+}–EDTA between pH 1.5 and 3.5; Mn^{2+}–EDTA between pH 1.0 and 6.0, and Tl^{+}–EDTA between 6.5 and 11.0. Optimal conditions for the titration of various metal ions, including Th, are reported. Polarographic active ions produce a V-formed curve, whereas polarographic inactive ions cause a ⎍-shaped curve. (auth)

8714 TIME-RESOLVED SPARK-SOURCE MASS SPECTROMETRY; THE EFFECT OF SPARK DURATION ON RELATIVE SENSITIVITY FACTORS, ION INTENSITY, AND PRECISION OF ANALYSIS. Franklin, James Curry. Knoxville, Tenn.; Univ. of Tennessee (1970). 135p. University Microfilms Order No. 71-17,735.

Thesis.

A radiofrequency, high-voltage spark ion source in conjunction with a double-focusing mass spectrometer was used to measure the relative sensitivity factors for several elements in matrices of tin, iron, beryllium oxide, uranium, and steels. The sensitivity factors were examined for concentration and matrix effects. No significant variations were found for the concentration ranges studied, but there were very large sensitivity variations with changes in the matrix type. The precision in determining concentrations and relative sensitivity factors was compared for two methods of data interpretation and, in one case, a decrease in precision was shown to be due to sample nonhomogeneity. Because of the lack of reproducibility in the relative sensitivity factors and the corresponding lack of accuracy, a study was made of ion-intensity variations with elapsed time in a radiofrequency spark pulse. Circuits were designed and installed to synchronize the ion-beam chopping circuits with the radiofrequency spark pulses so that time-resolved spectra were obtained at different periods in the spark pulse. Large variations in individual ion intensities were observed. In addition, the multiply charged species exhibited a behavior very different from the singly charged ions. The singly charged ion species gradually increased in intensity for the first 20 to 30 μsec of the spark pulse; but, after the initial pulse, a period of stable ion intensity was maintained until near the end of the spark pulse. In contrast, the multiply charged species reached a maximum abundance in 5 μsec or less; however, this large maximum was short-lived and fell to a minimum at the same time as the singly charged species reached a maximum. Relatively stable periods of ionization were observed in the interior of the spark pulse. Therefore, data were collected from the interior of the pulse using standard iron as the analytical sample. The analysis using the time-resolved beam pulse from the spark had significantly better precision than analytical results taken without the pulse. In fact, the precision improved from +11.1, −9.9% to +5.5, −5.2%, which was very near the limiting precision of the photographic emulsion. (Diss. Abstr. Int., B)

8715 STUDY OF THE REACTION OF MOLYBDENUM(VI) WITH MAGNESON IREA [5-CHLORO-2-HYDROXY-3-(2-HYDROXY-1-NAPHTHYLAZO)BENZENESULPHONIC ACID] IN NONAQUEOUS MEDIUM. D'yachenko, S. S.; Agrinskaya, N. A. Tr. Novocherkassk. Politekh. Inst.; 220: 108-13(1969). (In Russian).

A study of the species involved in this reaction, and of the spectrophotometric properties of the complex formed, showed that the reaction is suitable for the determination of $Mo^{(VI)}$ in, e.g., isoamyl acetate extracts of Mo from aqueous solutions 9M in HCl. (Referativnyi Zh.)

8716 PHOTOMETRIC DETERMINATION OF URANIUM AND RHENIUM WITH CRYSTAL VIOLET. Sokolova, L. S.; Shchemeleva, G. G.; Kovalenko, P. N. Tr. Novocherkassk. Politekh. Inst.; 220: 83-8(1969). (In Russian).

The anion $UO_2(C_6H_5COO)_3^-$ reacts stoichiometrically with crystal violet to form a colored compound extractable into organic solvents (preferably toluene); the molecular extinction coefficient of the extract is 7.6×10^4 at 610 nm. There was no interference from large amounts of Pb, Mn, Cu, Ni, Ag, Zn, Co, Cl^-, SO_4^{2-}, or acetate, or from small amounts of NO_2^-, NO_3^-, PO_4^{3-}, Br^-, or F^-. Iron interferes, but the interference can be prevented by adding PO_4^{3-} or a suitable chelating agent. The method was used to determine U in nickel and lead to within ±2%. Perrhenate also forms a colored complex with Crystal Violet, the optimum pH being 2.5 to 3.8; the molecular extinction coefficient is 4.4×10^4 at 610 nm, and the presence of benzoate improves the sensitivity. The determination of U and Re present together is based on the differences in extinction of extracts from aqueous phases at pH 4.1 (U and Re are extracted) and at pH 2.5 (only Re is extracted). The method was applied to the analysis of zirconium salts. (Anal. Abstr.)

8717 DETERMINATION OF URANIUM BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Martin, Margaret J. (Gas Council, London). Analyst; 96: No. 1149, 843-6(Dec 1971).

The determination of uranium by atomic-absorption spectrophotometry is complicated by significant interference effects and demands critical control of fuel composition and burner adjustment. For the determination of uranium in uranium-based nickel–uranium catalysts a solvent-extraction method was used to avoid the matrix effects. (auth)

8718 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH DIPHENYLTHIOVIOLURIC ACID. Chawla, R. S.; Singh, R. P.; Trikha, K. C. (Univ. of Delhi). Talanta; 18: No. 12, 1245-9(Dec 1971).

Diphenylthioviolurie acid (DPHTVA) reacts with ruthenium(III) to form a complex that has an absorbance maximum at 520 nm. Effects of pH, heating time, buffer, and reagent were studied. DPHTVA was found to be a sensitive reagent for ruthenium(III) (sensitivity = 0.0044 μg Ru/cm² for $\log I_0/I = 0.001$), and was made selective by the use of masking agents. The composition of the complex as revealed by different methods is 1 : 2 (ruthenium : DPHTVA). (auth)

8719 DETERMINATION OF THORIA IN THORIUM ORES BY AN EMISSION SPECTROGRAPHIC METHOD. Kothari, N. C. (James Cook Univ. of North Queensland, Townsville, Australia). Talanta; 18: No. 12, 1242-5(Dec 1971).

The emission spectrograph is used to determine thoria in monazite sand. A sample of only 15 mg is required and yields rapid and accurate results for 2% thoria or less. Of various additives tested as carriers, carbon and MoO_3 were found to be best. A current of 6 A gave a proper rate of volatilization without excessive spattering. The 267.28 nm Mo line was used as internal standard and the 269.24 nm Th line for analysis. Silica and iron sulphide were used as matrix in synthetic samples. Results compared well with those obtained by wet-analysis. (auth)

8720 CATALYTIC METHOD FOR THE DETERMINATION OF COBALT IMPURITIES IN REACTOR COOLING-WATER CIRCUITS. Batley, G. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Talanta; 18: No. 12, 1225-32(Dec 1971).

Metal impurities in reactor cooling-water circuits must be kept to a minimum. A method is described for the determination of trace levels of cobalt in water samples, based on catalysis of the hydrogen peroxide oxidation of Alizarin Red S. The determination is carried out at pH 11.0 in a phosphate buffer under conditions where the reaction rate is a maximum. Interfering impurities are removed by an ion-exchange separation. The method enables cobalt to be determined in water samples down to 10^{-4} μg/ml, or 5×10^{-5} μg/ml in samples where an ion-exchange separation is not required. (auth)

8721 DETERMINATION OF TRACES OF URANIUM IN SODIUM AFTER VACUUM DISTILLATION OF SODIUM; ISOTOPE DILUTION AND SPECTROPHOTOMETRIC METHODS. Takahashi, Masao; Matsuda, Yuji; Toita, Yukio; Ouchi, Miaso; Komori, Takuji (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 20: No. 9, 1085-91(Sep 1971). (In Japanese).

A study was made on the determination of traces of uranium in sodium metal by isotope dilution-mass spectrometry or by Arsenazo III spectrophotometry after the vacuum distillation of sodium using a stainless steel crucible. In the isotope dilution method, 5g of sample was taken into the crucible containing a known quantity of enriched isotope as a spike and distilled at 350°C under vacuum. Uranium in the residue was separated by trioctylamine extraction and the isotopic ratio was measured mass spectrometrically. It was confirmed by this method that uranium was not lost at all during the distillation. In the spectrophotometric method, after the distillation of sodium and removal of iron by ethyl ether extraction, uranium was reduced to uranium(IV) with zinc and determined spectrophotometrically. The limit of detection of uranium was about 1 ppB in the isotope dilution method and about 100 ppB in the spectrophotometric method. The content of uranium in sodium

metal determined by the former method was lower than 2 ppB. (auth)

8722 STUDIES ON THE HYDRAZONE DERIVATIVES IN FLUOROMETRIC ANALYSIS. II. FLUOROMETRIC DETERMINATION OF ALUMINUM. Uno, Toyozo (Kyoto Univ.); Taniguchi, Hirokazu. Jap. Anal.; 20: No. 9, 1123-8(Sep 1971). (In Japanese).

Four derivatives of 2-hydroxy-1-naphthaldehyde hydrazones (from acetic acid hydrazide, phenylacetic acid hydrazide, benzoic acid hydrazide and isonicotinic acid hydrazide) were synthesized. The spot test on the fluorescence due to the reactions between these hydrazones and various metal ions indicated that they were useful for the analysis of aluminum. 2-Hydroxyl-1-naphthaldehyde benzoic acid hydrazone (HNBH) gave the strongest fluorescence and a fluorometric method for the determination of aluminum was established by using HNBH. The recommended procedure was as follows. To a sample solution of 4 ml were added 1 ml of acetate buffer solution (pH 4.6), 6 ml of mixed solvent (CH_3OH : DMF = 2 : 1), and 2 ml of 0.004% HNBH in ethanol. The solution was then warmed at 40 ~ 42°C and was diluted to 20 ml with 50% methanol. Blue fluorescence with the maximum at 475 mμ was measured. From 0.1 to 1.0 μg of aluminum per ml was successfully determined. The effect of eighteen diverse elements was studied including thorium. (auth)

8723 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM WITH STILBAZO. Ozawa, Toshio (Tokyo Metropolitan Industrial Technology Center). Jap. Anal.; 20: No. 9, 1132-6(Sep 1971). (In Japanese).

Stilbazo reacts with zirconium to form a greenish blue complex. Its absorption spectrum had an isosbestic point at 585 mμ between pH 2.4 and 5.0 and the determination of zirconium was done by utilizing the wavelength 585 mμ and pH 3.0. Beer's law held for 0 to 1.2 μg Zr/ml. The molar extinction coefficient was $5.6_5 \times 10^4$, and the sensitivity for $\log(I_0/I) = 0.001$ was 1.6×10^{-3} μg Zr/cm^2. Beryllium, hafnium, indium, molybdenum, manganese, titanium, thorium, tungsten, vanadium(IV,V), phosphate, oxalate, citrate, and EDTA interfered seriously with the determination. The interference due to manganese and titanium could be removed by masking with sulfosalicylic acid, and the interfering molybdenum was masked with thioglycollic acid and tungsten with potassium thiocyanate solution including ascorbic acid. (auth)

8724 DETERMINATION OF MICROAMOUNTS OF CADMIUM AND ZINC IN COPPER, NICKEL, ALUMINUM, AND URANIUM METALS BY SOLVENT EXTRACTION–ATOMIC ABSORPTION SPECTROPHOTOMETRY. Kuroha, Toshiaki; Tsukahara, Iwao; Shibuya, Seiji (Furukawa Electric Co., Ltd., Tokyo). Jap. Anal.; 20: No. 9, 1137-42(Sep 1971). (In Japanese).

An atomic absorption spectrophotometric method for the determination of cadmium and zinc in copper, nickel, aluminum, and uranium metals was presented. This method involves the extraction of cadmium and zinc with methyl isobutylketone (MIBK) solution of trioctylamine and the measurements of absorbances of the extract. Ten milligrams of Be^{2+}, Bi^{3+}, Co^{2+}, Cr^{3+}, Mg^{2+}, Pb^{2+}, Sn^{4+}, and Zr^{4+}, 1 mg of As(III), Fe^{3+}, Ga^{3+}, In^{3+}, Mn^{2+}, and V(V) and 6N of SO_4^{2-} do not interfere. More than 1 mg of Fe^{3+}, 0.01 N of NO_3^-, and 0.001 N of CrO_4^{2-} interfere. More than 1 mg of Zn^{2+} and Te(IV) interfere with the determination of cadmium, and more than 0.1 mg of Cd^{2+} and Te(IV) interfere with the determination of zinc. As little as 0.5 ppM of cadmium and zinc in copper, nickel, aluminum and uranium metals can be determined by this method. (auth)

Isotope Dilution Procedures

8725 DETERMINATION OF IRON IN BIOLOGICAL MATERIAL BY SUBSTOICHIOMETRIC ISOTOPIC-DILUTION ANALYSIS. Gundersen, E.; Steinnes, E. (Institutt fuer Atomenergi, Kjeller, Norway). Talanta; 18: No. 11, 1167-9(Nov 1971).

Iron is determined in biological material by wet oxidation, in the presence of ^{59}Fe tracer, extraction of iron(III) chloride into isopropyl methyl ketone, stripping with nitric acid, and substoichiometric separation of the Fe–EDTA complex on a cation-exchanger. The precision is good and the method was applied to analysis of standard kale and blood. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 9299, 9322, 9330, 9343, 9351, 9355, 9356, 9360, 9361, 9401, 9409, 9521, 9540, and 10032.

8726 (AAEC/M–85) MANUAL OF PROCEDURES FOR THE RAPID ANALYSIS OF RADIOACTIVITY, RADIONUCLIDES, AND BERYLLIUM IN ENVIRONMENTAL SAMPLES. Piper, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1970. 41p. Dep. NTIS (U. S. Sales Only).

A comprehensive range of rapid procedures suitable for the chemical and radiochemical analysis of environmental samples in the event of accidental release of radioactivity or beryllium to the environment is presented. The methods are grouped according to the nature of the determination; a section of general appendices lists the reagents and equipment that must be stocked for the analyses. (auth)

8727 (UCRL–51086) ANALYSIS OF FUEL RODS BY GAMMA-RAY SPECTROSCOPY. Gunnink, R.; Tinney, J. F. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Aug 1971. Contract W-7405-eng-48. 84p. Dep. NTIS.

The effectiveness of gamma spectrometry in measuring the fissile content and isotopic abundances of nuclear fuel rods, using Ge(Li) and NaI(Tl) detectors, was studied. The Ge(Li) results showed that analyses accurate to within a few percent can be achieved for ^{239}Pu, ^{241}Pu, and ^{241}Am, and to within ±5% for ^{240}Pu. Simulation studies involving analysis of NaI(Tl) spectra indicate that under proper conditions, precisions of 1 to 2% for ^{235}U, ^{239}Pu, ^{241}Pu, and ^{241}Am are possible. Particular attention was given to the study of gamma interferences and their influence on the precision of the analyses. (auth)

8728 (UCRL–73274) TOTAL FISSILE CONTENT AND ISOTOPIC ANALYSIS OF NUCLEAR MATERIALS BY GAMMA-RAY SPECTROMETRY. Gunnink, R.; Tinney, J. F. (California Univ., Livermore. Lawrence Livermore Lab.). 19 Oct 1971. 19p. (CONF-711107–11). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

As part of a USAEC Plant Instrumentation Program, a series of plutonium-bearing solutions and mixed-oxide fuel rods were successfully analyzed by γ spectrometry, using high-resolution detectors and refined data-processing techniques. Several experiments were conducted to evaluate the precision and accuracy of analyses for various isotopes of interest. High-energy γ rays were measured using a 55-cc Ge(Li) detector, while low-energy x and γ spectra were obtained using small, high-resolution Ge(Li) x-ray detectors. Data reduction and spectral analyses were performed off-line, using noninteractive computer programs designed for interpreting γ spectra of complex isotopic mixtures. This necessitated a thorough characterization of the precise energies and absolute branching intensities of the x and γ rays for the appropriate isotopes, a study in which several new γ rays were uncovered. Particular attention was given to the influence on the quality of the results of a number of parameters, such as the sample form, detector efficiency and resolution, counting time, the peaks selected for analysis and any interferences involved, the isotopic composition of the sample, and the techniques used in analyzing the spectra. For solutions, the measurements generally agreed to within 0.3 to 2% of the values obtained by accepted techniques for all of the Pu isotopes of interest, (i.e., $^{238,239,240,241}Pu$ and ^{241}Am). Corresponding results for fuel rods were usually within 1 to 2% for ^{239}Pu, ^{241}Pu, and ^{241}Am. Determinations for ^{240}Pu (within 2% for dilute solutions and 5% for fuel rods) were successfully made by a careful analysis of the 104.23-keV photopeak. (auth)

8729 (USGS–474-134) DETERMINATION OF TRITIUM IN WATER BY THE U.S. GEOLOGICAL SURVEY, DENVER, COLORADO. Schroder, L. J. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 22p. (NTS–232). Dep. NTIS.

Tritium concentrations of water are determined using liquid scintillation techniques. Normally, 600 to 800 samples a year with a detection level ranging from 150 to 400 tritium units are analyzed. The methods and procedures used to analyze natural waters for tritium activity are described. (auth)

8730 SEPARATION OF ELEMENTS BY CHLORIDE SUBLIMATION. COMMUNICATION 1. A STUDY OF THE RARE EARTH CHLORIDE SUBLIMATION. Davydov, A. V.; Travnikov, S. S.; Myasoedov, B. F. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 10, 1936-42 (Oct 1971). (In Russian).

The effects of various factors (carrier material, starting temperature, value of temperature gradient, etc.) on the chlorination, sublimation, and the rare earth chloride transference were studied using ^{144}Ce and ^{152}Eu in a quartz tube with a temperature gradient as an example. Optimum conditions were established for isolating traces of the rare earths quantitatively. Under these conditions the separation of ^{144}Ce and ^{106}Ru, followed by their determination by a γ-spectrometric method, was carried out. (auth)

8731 ABSOLUTE ACTIVITY MEASUREMENT OF TRITIUM BY LIQUID SCINTILLATION COUNTING. Yura, Osamu. Radioisotopes (Tokyo); 20: No. 10, 493-7(Oct 1971).

The absolute activity of tritium was measured by liquid scintillation counting using a simplified efficiency tracing method in which ^{60}Co and ^{14}C of known activities were employed as tracers. The activity of a tritium standard solution was measured by this method within 1% of its original certified value. (auth)

8732 EXTRACTION METHOD FOR RAPID SEPARATION OF AMERICIUM FROM OTHER TRANSURANIUM AND FISSION PRODUCTS. Myasoedov, B. F.; Molochnikova, N. P.; Lebedev, I. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 10, 1984-93(Oct 1971). (In Russian).

A method was developed for the extraction separation of americium from curium and other transuranium elements. It is based on the ability of trivalent elements to be extracted from 0.1 M HNO_3 with a mixture of 0.05 M 1-phenyl-3-methyl-4-benzoylpyrazolone-5 and 0.025 M trioctylphosphine oxide in cyclohexane with high distribution coefficients (about 10^3), whereas americium(VI) is reduced under the same conditions to americium(V) and remains quantitatively in the aqueous phase. The influence of the composition of the aqueous and organic phases, the nature of the solvent, the time of oxidation and extraction, and some other factors on the effectiveness of americium separation from other elements was studied in detail. The behavior of Np, Pu, Cm, Bk, Cf, Ru, Cs, Zr, Nb, and other elements under optimum conditions for the extraction separation of americium was examined. A radiometric method was developed for determining americium in solutions of complex composition including those that contain large amounts of curium. (auth)

8733 DOUBLE-ISOTOPE DERIVATIVE ASSAY OF METHYLGLYOXAL. Walton, D. J.; McLean, Sharon A. (Queen's Univ., Kingston, Ont.). Anal. Biochem.; 43: No. 2, 472-80(Oct 1971).

A double-isotope derivative technique was developed for the selective assay of methylglyoxal in tissues. A measured amount of [1,3-^{14}C]methylglyoxal is added to the unknown sample and the bis-[3,5,6-^{3}H]2,4-dinitrophenylhydrazone is then prepared. The double-labelled derivative is purified by TLC (thin-layer chromatography) and both radioisotopes are counted. The ratio of ^{3}H to ^{14}C is a linear function of the amount of methylglyoxal in the sample. The lower limit for the analysis is 10 nmoles (0.7 μg) of methylglyoxal. In rat liver, no endogenous methylglyoxal was detected by this method. A previous report on the conversion of fructose 1,6-diphosphate into methylglyoxal was not substantiated. (auth)

8734 PRECISE DETERMINATION OF THE NATURAL ABUNDANCE OF ^{237}Np AND ^{239}Pu IN KATANGA PITCHBLENDE. Myers, William A.; Lindner, Manfred (Univ. of California, Livermore). J. Inorg. Nucl. Chem.; 33: No. 10, 3233-8(Oct 1971).

Improvements in instrumentation and techniques made possible accurate determination of the natural abundances of ^{237}Np and ^{239}Pu from the same sample of pitchblende ore weighing no more than 10g. The abundance of ^{237}Np in the sample of Katanga pitchblende was $2 \cdot 6 \times 10^{-12}$ atoms per atom of ^{238}U, while that of ^{239}Pu was $3 \cdot 10 \times 10^{-12}$ atoms per atom of ^{238}U. The uncertainties of the determinations were less than 5%. (UK)

8735 X-RAY ABSORPTION METHOD FOR QUANTITATIVE ANALYSIS. Broquet, Claude (to Commissariat a l'Energie Atomique). French Patent 2,045,683. 5 Mar 1971. Filed 19 Jun 1969. (In French).

A procedure using x-ray absorption to determine the content of an element in solution in water or an organic solvent is described. The procedure may be used to examine any fluid mixture and is especially suitable for measuring the quantity of an element in a gaseous mixture, or in suspension in a liquid or gaseous medium. The method is accurate and easily set up. The attenuation in the intensity of an x-ray beam traversing a given thickness of fluid is measured. The measurements are carried out using two different energy radiations, and two different thicknesses of fluid in a ratio inversely proportional to the absorption coefficients at the different energies. The ratio of the attenuations obtained is calculated. One of the energies is equal to or a little above that of the absorption discontinuity of the element. The equipment used is described. (France)

8736 DETERMINATION OF SULPHATE IN SOILS AS THE $^{133}BaSO_4$ PRECIPITATE. Kao, C. W.; Graham, E. R.; Blanchar, R. W. (Univ. of Missouri, Columbia). Soil Sci.; 112: No. 4, 221-4(Oct 1971).

A study to develop a rapid method for routine analysis of low levels of sulfate in soils revealed the following: (a) sulfate contents of 5 mM $CaCl_2$ extracts of soils may be determined as $^{133}BaSO_4$ precipitates. The aliquot taken should contain at least 0.3 μg SO_4^{2-}. By precipitating the sulfate from 1.0 ml of the soil extract, 12 g of soil extracted with 30 ml of 5 mM $CaCl_2$, soil levels of sulfate as low as 1 μg SO_4^{2-}/g soil may be determined. (b) Cation interference was removed by passing the extract through a hydrogen-saturated cation exchange resin. Phosphate interference was eliminated by washing the precipitated $^{133}BaSO_4$ with anhydrous methanol and 0.1 N HCl. (c) It was estimated that approximately 60 samples per day could be determined using this procedure. (d) The standard deviation calculated between paired comparisons of 24 soil samples ranging from 9 to 134 μg SO_4^{2-}/g soil was 7.4 μg SO_4^{2-}/g soil. (auth)

8737 RADIOCHEMICAL ANALYSIS OF LARGE QUANTITIES OF MATERIALS. Lawless, James L.; Willoughby, Otis H. (to United States Atomic Energy Commission). U. S. Patent 3,597,596. 3 Aug 1971. Filed 7 Feb 1969.

An apparatus and method are described for measuring radiation from bulk quantities of materials such as waste materials or ash to determine quantities of radiochemical substances included therein comprising a container for the materials, radiation detection means radially arranged about the container, a device for producing rotation and translation relative to the container, and radiation detection means and means for compensating for material density changes. (auth)

8738 AUTOMATIC AND NONDESTRUCTIVE SCANNING OF ^{14}C AND ^{3}H ON TWO-DIMENSIONAL CHROMATOGRAMS. Wenzel, Martin; Hoffmann, Katharina (Freie Univ., Berlin). Anal. Biochem.; 44: No. 1, 97-105(Nov 1971).

With a usual chromatogram-scanner, programmable for movement of chromatogram and recorder-paper along the X- and Y-axes, the scanning of two-dimensional chromatograms with ^{14}C- and ^{3}H-labeled substances is demonstrated. The only additional equipment needed is a dot-printer, which is exchanged for the pen-recorder of the scanner. The radioactive distribution on thin-layer chromatograms containing 0.001 μCi ^{14}C and for 0.008 μCi ^{3}H separated in several spots can be detected in an overnight scan without modifying the chromatogram in any way. Quantitative evaluation of the radioactivity in different spots by counting the number of corresponding dots showed good agreement with actual radioactivity in the spots. The separation of double-labeled ($^{3}H/^{14}C$) compounds on the same spot was possible. (auth)

8739 PROBLEMS IN THE RADIOMETRIC ASSESSMENT OF PROTEIN AND NUCLEIC ACID SYNTHESIS. Oldham, K. G. (Radiochemical Centre, Amersham, Eng.). Anal. Biochem.; 44: No. 1, 143-53(Nov 1971).

The synthesis of proteins and nucleic acids is usually assessed radiometrically by measuring the incorporation of radioactivity from precursors of low molecular weight. When only a small proportion of the radioactivity is incorporated into the product, there is a danger that trace impurities, in the precursor or acceptor, might cause a significant but spurious incorporation of activity. As a result, failure to identify the product or the true precursor can lead to a false inference of macromolecular synthesis. In enzymic assays, this spurious incorporation of activity from trace impurities results in high blank readings that reduce the sensitivity and accuracy of the assays. The control experiments usually employed in these assays do not always compensate fully for the spurious incorporation of activity, and the assumption that they do so can lead to the misinterpretation of results. Catabolism of nucleic acid precursors can also lead to false assessments of synthesis. The factors that can result in such misinterpretations, methods of reducing their effect, and simple methods of identifying products and true precursors, are discussed. (auth)

8740 LIQUID SCINTILLATION QUENCH CORRECTION USING ^{113m}In CONVERSION ELECTRONS AS AN INTERNAL STANDARD. Oldendorf, William H. (Wadsworth General Hospital, Los Angeles. Univ. of California, Los Angeles). Anal. Biochem.; 44: No. 1, 154-8(Nov 1971).

A method of liquid scintillation quench correction is described using ^{113m}In as an internal standard. A small amount of ^{113m}In is added to each specimen bottle. The conversion electrons of ^{113m}In create a sharp pulse-height spectral peak whose height is determined by spectral scanning with a narrow pulse-height window. The height of the pulse at this spectral peak is linearly related to the efficiency of light output (quench) of the liquid scintillation bottle. The specimen is counted for its beta emitter 12 to 24 hr later when the ^{113m}In has decayed. This internal standard method is compared with more common method of automatic external standard quench correction using an external gamma emitter.

The present method should allow an inexpensive, more precise, correction through a wide range of quenching. (auth)

8741 DIRECT COUNTING OF NUCLEOTIDE ^{32}P ADSORBED ON CHARCOAL USING A SCINTILLATION SPECTROMETER. Shiga, Takeshi; Shiga, Kiyoshi; Kuroda, Masao (Osaka Univ.). Anal. Biochem.; 44: No. 1, 297-8(Nov 1971).

Satisfactory results of counting charcoal samples containing ^{32}P-labeled nucleotide could be obtained when the color quenching of the dark charcoal material was limited. This was achieved by placing the charcoal in a small polyethylene tube before inserting it in the polyethylene scintillation vial. The highest counts were obtained with the use of toluene as the outer medium in the counting vial. (M.C.G.)

8742 SMALL-SCALE DEGRADATION OF ^{14}C LABELLED CARBOXYLIC ACIDS. II. COMPLETE DEGRADATION OF ^{14}C LABELLED PROPIONIC AND n-BUTYRIC ACIDS. Susan, A. B.; Nystrom, R. F. (Univ. of Illinois, Urbana). J. Label. Compounds; 7: No. 3, 275-82(1971).

A chemical degradation and radioassay procedure is described for finding the radioactivity in each carbon atom of carbon-14-labeled propionic and n-butyric acids. This method was tested with suitably labeled compounds and found to be isotopically reliable. (auth)

8743 SMALL SCALE DEGRADATION OF ^{14}C LABELLED CARBOXYLIC ACIDS. I. MODIFICATION OF THE HUNSDIECKER REACTION. Susan, A. B.; Nystrom, R. F. (Univ. of Illinois, Urbana). J. Label. Compounds; 7: No. 3, 269-74(1971).

A modified Hunsdiecker reaction is described for degradation of the silver salts of acetic acid-$1^{-14}C$, acetic acid-$2^{-14}C$, propionic acid-$1^{-14}C$, propionic acid-$3^{-14}C$, n-butyric acid-$1^{-14}C$ and n-butyric acid-$2^{-14}C$ to carbon dioxide, silver bromide, and an organic bromide containing one less carbon atom than the acid, on a 0.5 to 10 millimole scale. This reaction is performed by allowing the silver salt of a carbon-14-labeled acid to react with bromine vapor in a sealed tube. Then the separation, purification, and determination of the amount of each degradation product is accomplished by use of high vacuum techniques. Finally, the products obtained in a radiochemically pure form are analyzed for radioactivity by liquid scintillation counting. (auth)

8744 NEW DEVELOPMENTS IN THE TECHNIQUES OF RADIOMETRIC TITRATION. Toelgyessy, J. (Technical Univ., Bratislava). Isotopenpraxis; 7: No. 6, 208-17(Jun 1971).

Some new techniques and results of radiometric end-point detection are considered. End-point detection by ion-exchange separation, by neutron absorption, and with the aid of radioactive kryptonates is discussed. (61 references). (M.C.G.)

8745 DETERMINATION OF THE QUANTITY OF POTASSIUM HAVING NEGLIGIBLE RADIOMETRIC EFFECTS UPON RADIOACTIVITY MEASUREMENT CARRIED OUT ON VEGETABLE SAMPLES. II. DETERMINATION OF THE MAGNITUDE OF SAMPLE CONTAINING ^{40}K. Seidel, H. O.; Zaduban, M. (Safarik-Univ., Kosice, Czech.). Isotopenpraxis; 7: No. 6, 226-31(Jun 1971). (In German).

On the basis of the equivalence existing between the quantity of potassium and the corresponding counting rate (^{40}K), correlations are specified that render possible determination of the quantity of potassium having a negligible radiometric effect with varying total efficiency of measurement. The quantities of potassium are cited that have a negligible radiometric effect on radioactivity measurements carried out on some kinds of food, thus covering the most relevant cases of measurement of the total radioactivity of mixtures of fission products by means of beta radiation. (auth)

8746 HEAVY ELEMENT ANALYSIS BY ISOTOPE-EXCITED X-RAY FLUORESCENCE. Kuusi, J.; Virtanen, M.; Jauho, P. (State Inst. for Tech. Research, Otaniemi, Finland). Nucl. Technol.; 13: No. 2, 216-24(Feb 1972).

One of the advantages of radioisotope x-ray techniques is the potential for using primary radiation, which has enough energy to excite K x rays of even the heaviest elements. In using these penetrating x rays in the analysis, the effects of some of the most severe sources of error in x-ray techniques are less significant than when using softer L x rays. The advantages of isotope-excited K x-ray determinations of heavy elements are illustrated theoretically, and some feasibility studies and applications such as the determination of lead in zinc and tungsten in mineral samples are described. (auth)

8747 RADIOCHEMICAL POLAROGRAPHY OF $^{65}Zn^{2+}$ WITH A DROPPING ELECTRODE OR A MERCURY SHEATH ELECTRODE. Duflo-Plissonnier, M. (Institut du Radium, Paris). Radiochem. Radioanal. Lett.; 8: No. 5, 277-84(18 Dec 1971). (In French).

Radiochemical polarography of $^{65}Zn([(CH_3)_4NClO_4] = 0.05M$, pH ~ 2, $[Zn^{2+}] \sim 5 \times 10^{-7}M$) with a dropping electrode or with a mercury sheath electrode gives identical results. Thus it seems to be probable that reactions do not occur during the fall of the drop. Secondary reactions observed at potential below −1.6 V appear to be related to the concentration of the reactants. With the dropping electrode, measured radioactivity corresponding to the diffusion current gives a diffusion coefficient of $7 \pm 0.3 \times 10^{-6}$ cm$^2 \cdot$ s^{-1} for ^{65}Zn. (auth)

8748 NEW RADIOCHEMICAL METHOD FOR ASSAY OF INORGANIC PYROPHOSPHATASE. Cartier, Pierre H.; Thuillier, Laure (Hopital des Enfants-Malades, Paris). Anal. Biochem.; 44: No. 2, 397-403(Dec 1971).

A radiochemical method for the assay of inorganic pyrophosphatase has been developed. Inorganic pyrophosphate labeled with ^{32}P is used as substrate and hydrolyzed orthophosphate is separated after the reaction by selective precipitation as phosphomolybdic-triethylamine complex. The radioactivity of the supernatant ($^{32}PP_i$) and of the precipitate solubilized in acetone ($^{32}P_i$) is measured. In this rapid separation, spontaneous hydrolysis of pyrophosphate is avoided. This method does not involve the colorimetric determination of orthophosphate, and is insensitive to the presence of many compounds that may disturb the colorimetric assay of pyrophosphatase (acid-labile, phosphate esters, phosphate buffer, reducing compounds, etc.). The method is very sensitive and pyrophosphatase activities in the range of 10^{-2} to 10^{-4} IU may be assayed with precision and reproducibility. (auth)

8749 SAMPLING AND ANALYSIS OF SAMPLES CONTAMINATED BY A COMPLEX MIXTURE OF FISSION PRODUCTS. Miribel, J.; Rzekiecki, R.; Wilzer, R. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 45-58(Apr 1971). (In French).

Radiological safety experiments involve the sampling of radioactive iodine and aerosols in a gas at room temperature, or at a high temperature. The nature of the trap used for the iodine depends upon its physicochemical state. Fission gases are sampled using a liquid nitrogen-cooled trap. Gamma spectrometry using a Ge−Li detector is used to analyze the samples. The spectra obtained are analyzed using a teleprocessing terminal. The nuclear characteristics of 661 nuclides are stored in the computer. The best sampling conditions can be determined from preliminary tests with inactive tracers. (France)

8750 RAPID EVALUATION OF ACTIVITY IN CONTAMINATED WATERS BY MEANS OF ION EXCHANGE RESINS AMBERLITE 200 AND AMBERLITE 402. Konecny, J.; Keltos, D. Radioisotopy; 11: No. 4, 693-703(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

A separation method for radioactive iodine, cesium, and strontium was developed. Radioiodine is absorbed on Amberlite 402 and radiostrontium and radiocesium on Amberlite 200. The radiostrontium is eluted with a solution of EDTA at pH 7.8. From the acidified EDTA solution the strontium is adsorbed on Amberlite 200. The activities of radioiodine and of radiocesium are measured in a well-type scintillation crystal directly on the columns; the radioactivity of strontium is measured with a GM counter. The method was checked on samples of surface and drinking water. The total analysis requires about 2.5 hr, whereby the determination of radioiodine activity requires 1.5 to 2 hr, of radiocesium about 2 hr, and that of radiostrontium about 2.5 hr. (auth)

Activation Procedures

Refer also to abstracts 8780, 8878, and 9151.

8751 (GULF-RT-A-10684) DEVELOPMENT OF NUCLEAR ANALYTICAL TECHNIQUES FOR OIL-SLICK IDENTIFICATION. Phase IIA, Final Report. Lukens, H. R.; Bryan, D.; Hiatt, N. A.; Schlesinger, H. L. (Gulf Radiation Technology, San Diego, Calif.). 11 Jun 1971. Contract AT(04-3)-167. 132p. Dep. NTIS.

A program was carried out to investigate the use of nuclear techniques for oil slick identification. Necessary procedural steps in the comparison of slick and suspected source oils are defined. The major effort was given to the determination, by neutron activation analysis, of qualitative/quantitative trace element patterns (TEP's) in a wide variety of oils, especially from random oil slicks and candidate pollution sources, and in develop-

ing an objective means of comparing the TEP's. Among nearly 300 TEP's gathered in this work were sets of random samples from each coastal region of the United States, sets of samples containing duplicate aliquots of the same oil, and sets of highly similar (but different) petroleum products. This data base enabled the development and testing of a procedure for comparing TEP's of two oils that ascertains with ~99.999% certainty whether the samples are of the same oil or of different oils. (auth)

8752 (LA-4833) TECHNIQUES FOR ACTIVE ^{3}He ACTIVATION ANALYSIS FOR CARBON AND OXYGEN. Sanders, Wm. Mort (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 173p. Dep. NTIS.

The surface and body concentrations of carbon and oxygen were measured in various materials using ^{3}He activation. Channeling techniques were used to differentiate between interstitial and substitutional location of these impurities. Thin target excitation functions were determined for (^{3}He,p) reactions with carbon and oxygen over a ^{3}He energy range from 2.5 to 9.0 MeV. These data were used to calculate the activation curves for various combinations of incident particle energy, impurity distributions, and material. Information on several computer codes used during this study is presented. (auth)

8753 (LYCEN-7156) DETERMINATION OF OXYGEN IN Mo USING α PARTICLES. Faure, Lyliane; Boissier, Michele; Tousset, Jean (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 16p. (In French). Dep. NTIS (U. S. Sales Only).

A method of determining oxygen in Mo by means of α activation analysis is described. The fluorine is separated by extraction with diphenyldichlorosilane. The results obtained for oxygen surface concentrations, using nuclear reactions induced by low energy deuterons, are recalled. (auth)

8754 (LYCEN-7157) DETERMINATION OF OXYGEN IN LEAD AND LEAD-ANTIMONY USING α PARTICLES. Faure, Lyliane; Giroux, J.; Tousset, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 17p. (In French). Dep. NTIS (U. S. Sales Only).

A method of determining oxygen in lead and in lead-antimony alloys by α activation analysis is described. The separation of the fluorine resulting from the irradiation of the oxygen is effected by extraction with diphenyldichlorosilane in isopropyl ether. In the case of the lead-antimony alloy, a more complex separation process involving the isolation of the fluorine from the iodine produced by irradiating the antimony is described. (France)

8755 (RLO-2221-T-3-1) ROLE OF PAPER MILL ADDITIVES AS POTENTIAL STREAM POLLUTANTS DEVELOPMENT OF NUCLEAR ANALYTICAL TECHNIQUES. Annual Report, June 1, 1970-June 1, 1971. Chatters, Roy Milton (Washington State Univ., Pullman. Research Div.). 1 Jul 1971. Contract AT(45-1)-2221. 55p. Dep. NTIS.

Paper mill additives may be potential contaminants when released to the environment. This study was undertaken to develop nuclear analytical techniques where needed for better controlling paper mill additives to prevent their release into the environment as pollutants. Reported in this document are the results of the first year's investigations. The major portion of the effort was applied to the determination of starch as it makes up the second largest tonnage of all additives used by the paper industry. It is exceeded in quantity used in the industry only by clays. Other additives studied to a lesser degree were clay, sizing, and a bleaching compound. From these techniques, an effort is being made to add to or improve presently used non-nuclear routine analytical procedures for use by mill personnel. Wherever possible during the investigations to date, samples for study were collected in cooperating paper mills under normal conditions. All test materials used in the laboratory were obtained from mill stocks or from the suppliers of paper mill additives. (M.C.G.)

8756 NEUTRON ACTIVATION ANALYSIS USING DAUGHTER ACTIVITY. Wilkinson, B. W.; Toth-Allen, J. (Michigan State Univ., East Lansing). Nucl. Technol.; 13: No. 1, 103-5 (Jan 1972).

The neutron activation analysis of platinum (an element that yields a short-lived radioactive species—^{199}Pt) in biological tissue was demonstrated by the analysis of the longer-lived radioactive ^{199}Au daughter of the ^{199}Pt. The longer-lived gold allows the radiochemical separation of sodium from the trace elements present in biological tissue and permits a more leisurely counting technique. Linearity of the net counts per μg of platinum versus μgm of platinum added was demonstrated. This technique provides a useful method for the analysis of any element whose short-lived radioisotope decays to a longer-lived daughter. (auth)

8757 INVESTIGATION OF FLUORINE DEPOSITS ON ZIRCALOY SURFACES BY PROTON ACTIVATION. Mackintosh, W. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Technol.; 13: No. 1, 65-71(Jan 1972).

Pickling, sizing, and descaling of Zircaloy with HF leaves firmly bound fluorine on the surface. This deposit can be determined by proton activation utilizing the $^{19}F(p,\alpha\gamma)^{16}O$ reaction. The method described herein involves comparing γ-ray yields from the sample and a comparative standard. The errors inherent in comparing targets of different thicknesses of deposit (hence different effective cross sections) are calculated. As little as 0.01 $\mu g/cm^2$ can be determined. The total thickness can be obtained simply. Some results for nuclear reactor components and test coupons are given. (auth)

8758 RECENT DEVELOPMENTS IN THE APPLICATIONS OF ACTIVATION ANALYSIS TO MEDICINE AND BIOLOGY. Comar, D. (CEA, Orsay, France). Ind. At.; 15: No. 3, 22-6 (Jul 1971). (In French).

New applications of activation analysis to medicine and biology have been developed. The use of stable indicators allows metabolic processes to be studied for which the use of radioindicators would be impossible or dangerous; in vivo activation analysis is the only method currently available for studying directly the elementary composition of a living organism. (France)

8759 CERTAIN POSSIBILITIES OF ACTIVATION ANALYSIS BY RESONANCE NEUTRONS. Damburg, N. A.; Pelekis, L. L. (Inst. of Physics, Riga). Zh. Anal. Khim.; 26: No. 10, 1869-73(Oct 1971). (In Russian).

To elucidate the possibilities of γ spectrometry in activation analysis the following values were measured experimentally: (a) cadmium ratios for 53 isotopes at the thickness of the cadmium filter of 0.5 mm, (b) cadmium/boron ratios for a filter of 0.5 mm Cd + 2.0 mm B_4C, and (c) cadmium/indium ratios for a filter of 0.5 mm Cd + 0.1 mm In. The data obtained experimentally permit the effectiveness and sensitivity of the resonance activation method to be estimated for any combination of the determined and interfering isotopes. The data can be used for developing selective methods of activation analysis. Activation with resonance neutrons permits, in a number of cases, a sharp decrease in the induced activity of matrix elements, and thus improves radiological conditions of work with irradiated samples. (auth)

8760 SYSTEMATIC ANALYSIS OF MOLYBDENUM BY NEUTRON ACTIVATION. Fedoroff, M. (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Ann. Chim. (Paris); 6: No. 2, 159-72(Mar 1970). (In French).

An ion exchange method in the presence of H_2O_2 was used for separating the various elements produced by irradiation of Mo and Tc. Further separations between the elements were performed using ion exchange, extraction, and precipitation methods. The concentration of forty elements was determined with detection limits lower than 0.1 $\mu g/g$ for a neutron flux of 3×10^{12} $cm^{-2} \times s^{-1}$. The results show that the melting of Mo in a high vacuum reduces total impurities to lower than 1 $\mu g/g$ except for W. This last element was eliminated by ion exchange. When Nb is present, it must be separated prior to neutron irradiation of the Mo sample so that Zr might be determined accurately. (France)

8761 RADIOANALYTICAL METHODS APPLIED TO AIR-SEA INTERACTION STUDIES. Wilkniss, P. E.; Bressan, D. J.; Larson, R. E. (Naval Research Lab., Washington, D. C.). Isotop. Radiat. Technol.; 9: No. 2, 162-6(Winter 1971-1972).

Evidence is presented that activation analysis is an excellent way to determine the composition of aerosols. Elemental ratios derived therefrom can distinguish between oceans and continents as the sources of aerosols and have potential for differentiating airborne continental dust, volcanic dust, and polluted air. A laboratory experiment with radionuclide tracers simulated the bubble-bursting process whereby particulates are transferred from the ocean to the atmosphere. The results, compared with those for real marine aerosols, showed that the technique should be useful for laboratory-scale study of the environment. (auth)

8762 AUTOMATIC INDUSTRIAL ACTIVATION-ANALYSIS SYSTEM FOR SLURRIES USING A RADIOISOTOPE NEUTRON SOURCE. Blake, Kenneth R.; Ashe, John B.; Berry, Peter F.; Nelson, John B. (Nuclear-Chicago Corp., Austin, Tex.). Isotop. Radiat. Technol.; 9: No. 2, 167-72(Winter 1971-1972).

A neutron activation analysis system is described for the on-line measurement of silica in iron ore slurries. The system

is currently being used 24 hr/day in Canadian and U. S. iron ore processing plants. A ^{238}Pu–Be neutron source is used to activate the silica in the iron-ore slurry, which is continuously recirculated between the source and a NaI(Tl) detector. The system is automatically compensated for variation of the solids content of the slurry by means of a γ transmission gage. The analyzer may be coupled to a computer for rapid feedback of analysis results to the plant process-control system, or the percent silica can be printed out on paper tape or provided as an analog signal. The standard deviation between neutron activation and wet-chemistry silica determinations was ±0.10% silica in the concentration range 3 to 11% silica. (auth)

8763 IN SITU ELEMENTAL ANALYSIS FOR OCEANOGRAPHIC APPLICATIONS. Reed, J. H.; Mandler, J. W. (Illinois Inst. of Tech. Research Inst., Chicago). Isotop. Radiat. Technol.; 9: No. 2, 183-4(Winter 1971-1972).

Neutron activation was used for the in situ analysis of dunite, which is chiefly $(Mg,Fe)_2SiO_4$. In one series of tests, a radioactive neutron source (^{239}Pu–Be, 10^6 n/sec) was used with a 7-mm Ge(Li) detector and in a second series, a 14-MeV pulsed-neutron source with a 3 by 3 in. NaI(Tl) detector. The high resolution of the Ge(Li) detector largely obviated the advantage of pulsed operation, although the high-neutron machine source has the advantages that it can be turned off and requires no shielding. The method is also suitable for the analysis of Mn-containing nodules. (P.C.H.)

8764 Mn CONTENT OF MAIZE ETIOPLASTS WHEN TURNING GREEN. Joyard, Jacques; Fourcy, Andre (CEN, Grenoble, France). Compt. Rend., Ser. D; 273: No. 5, 572-5(2 Aug 1971). (In French).

Neutron activation analysis was used to study the changes in the Mn content of maize etioplasts when turning green. The carotenoids are more suitable for these measurements than the chlorophylls. The increasing content of Mn presents several phases, in particular, at the beginning of the illumination and after 24 hrs. (France)

8765 ACTIVATION ANALYSIS OF ATMOSPHERIC AEROSOL. Maebashi, K. (Meteorological Research Inst., Tokyo); Katuragawa, H. Tenki (Meteorol. Soc. Jap); 17: No. 11, 549-55 (Nov 1970). (In Japanese).

In order to study substances constituting atmospheric aerosol particles, elements in the atmospheric aerosol particles detectable by thermal neutron activation analysis were investigated. Na, Al, Cl, V, Mn, K, Sc, Fe, Zn, Br, and Sb were detected in all samples gathered in four places. The atmospheric aerosol particles were separated into giant, large, and Aitken particles according to their size, and the chemical composition was investigated. Al and Sc were concentrated in the giant particles, while V, Cl, and Br were concentrated in the Aitken particles. This result indicates that the giant particles were formed by degradation of soil, while the Aitken particles were formed artificially. (auth) (Japan)

8766 SIMULTANEOUS DETERMINATION OF COBALT, COPPER, and MANGANESE IN HIGH PURITY OPTICAL GLASS BY THERMAL NEUTRON ACTIVATION. Kim, C. K.; Voris, S. S.; French, W. G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Glass Technol.; 12: No. 5, 128-30(Oct 1971).

Submicrogramme quantities of cobalt, copper, and manganese in high-purity optical glass were simultaneously determined by thermal neutron activation. The radionuclides for identification of cobalt, copper, and manganese were ^{60m}Co ($T_{\frac{1}{2}} \simeq 10.5$ min), ^{64}Cu ($t_{\frac{1}{2}} \simeq 12.8$ h), and ^{56}Mn ($t_{\frac{1}{2}} \simeq 2.58$ h). Immediately following a neutron irradiation of 10 min, the samples were dissolved in a hot mixture of HF and H_2SO_4 and the cobalt was separated from the rest by a single step solvent extraction. Positive identification of ^{60m}Co was made by detecting the isomeric transition photon at 59 keV and measuring its half-life by means of γ scintillation spectrometry. Copper was isolated from the aqueous solution by dithizone–chloroform extraction. Identification was made by counting positron annihilation quanta emitted by ^{64}Cu and following its decay half-life of 12.8 h. Manganese was separated by precipitation of manganese dioxide, and identified by measurement of the γ photopeak at 0.847 MeV emitted from ^{56}Mn and by verifying its half-life of 2.56 h. The entire analysis was made in less than 1 h, and the procedure is essentially free from contamination. Furthermore, the method is extremely sensitive, the practical lower limit of detection for cobalt, copper, and manganese being about 10^{-10} g. (auth)

8767 RADIOISOTOPE TECHNIQUES FOR MEASUREMENT AND CONTROL OF INDUSTRIAL POLLUTION. Cameron, J. F. (Nuclear Enterprises Ltd., Reading, Eng.). Meas. Contr.; 4: No. 11, 303-7(Nov 1971).

Radioisotope techniques used for measurement and control of industrial pollution include radioisotope instruments and tracers, activation analysis, and radiation treatment of waste water and processing of chemicals. Radioisotope instruments monitor and control potential sources of pollution such as sulphur in hydrocarbons or ash in coal and papers, measure the concentration of pollutants in air and water, and assist in the control of sewage treatment plants. Activation analysis provides a sensitive, specific and versatile method for elemental analyses of pollutants in air, water, plants and animals, while radioisotope tracer techniques permit the study of the movement of liquid effluents and atmospheric pollutants, and trace the origins of oil spillages. Radiation treatment of waste water is feasible but uneconomic at present, and radiation processing can produce chemicals useful in combating pollution. (auth)

8768 USE OF NEUTRON ACTIVATION ANALYSIS TO DETERMINE THE COMPOSITION OF BLENDED SAMPLES OF ASBESTOS. Morgan, A. (Atomic Energy Research Establishment, Harwell, Eng.); Timbrell, V. Int. J. Appl. Radiat. Isotop.; 22: No. 12, 745-51(Dec 1971).

In a blending trial, approximately equal weights of chrysotile and crocidolite asbestos were blended by manual and mechanical methods. To determine the homogeneity of the mixture, samples of both types of asbestos and of the blended material were irradiated with thermal neutrons. Measurements of the induced ^{46}Sc, ^{51}Cr, ^{59}Fe, and ^{60}Co were used to show that the content of chrysotile in 10-mg samples of blended material had a mean of 51.1% and a standard deviation of 2.7%. (auth)

8769 TRACE ELEMENT ANALYSIS OF ENVIRONMENTAL SAMPLES BY NEUTRON ACTIVATION METHOD. Bhagat, Surinder K.; Funk, William H.; Filby, Royston H.; Shah, K. R. (Washington State Univ., Pullman). J. Water Pollut. Contr. Fed.; 43: No. 12, 2414-23(Dec 1971).

The neutron activation method for trace element analysis involves exposing the sample to a high flux of neutrons, which produces radioisotopes that can be identified by their characteristic decay rates and type and energy of emitted radiation. Irradiation can be achieved with either thermal or fast neutrons. Limits of detection depend on the element and range from 3×10^{-5} to 900 ppB. Size of neutron flux influences the sensitivity. Standardization is accomplished with solutions of known composition. Precautions must be taken to avoid sample contamination because of the low concentrations involved. The technique may be used in investigation of pollution and nutrients and in other applications. (auth)

8770 SMALL-SCALE DEGRADATION OF ^{14}C LABELLED CARBOXYLIC ACIDS. III. DEGRADATION OF ACETIC ACID–^{14}C. Numrich, R.; Nystrom, R. F. (Univ. of Illinois, Urbana). J. Label. Compounds; 7: No. 3, 283-9(1971).

A simple and rapid degradation procedure is described for the determination of the millimolar radioactivity of the methyl and carboxyl groups in carbon-14-labeled acetic acid. The barium salt of the acid is converted to barium carbonate and carbon dioxide by using pyrolysis in tandem with combustion at 500°C. (auth)

8771 DETERMINATION OF TRACE ELEMENTS IN RUBY LASER CRYSTALS BY NEUTRON ACTIVATION ANALYSIS. Thompson, Barbara A.; Miller, Eric C. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 75A: No. 5, 429-33(Sep-Oct 1971).

Methods are described by which concentration levels were determined for up to ten different trace elements and upper limits established for over 40 additional elements at ppM level or below in ruby crystals using neutron activation analysis. This information is required to determine the effect of trace element levels on laser performance. With conventional analytical methods difficulties arise because of both the refractory and insulating properties of the material. Because the crystals cannot be readily dissolved, the activation analysis was carried out nondestructively, irradiating the samples with highly thermalized neutrons to minimize formation of ^{24}Na and ^{27}Mg from (n,α) and (n,p) reactions on the Al_2O_3 matrix, and using a 47-cm^3 Ge(Li) detector. (auth)

8772 OPTIMIZATION OF THE NUMBER OF CYCLES IN CYCLIC ACTIVATION ANALYSIS. Janczyszyn, J.; Gorski, L. (Inst. of Nuclear Techniques, Krakow). Radiochem. Radioanal. Lett.; 8: No. 5, 297-304(18 Dec 1971).

Based on the known theory of cyclic activation techniques, the theory of cyclic activation analysis with sample transport is presented. A plot for the selection of the optimum number of cycles was constructed, assuming the maximum detector response as a criterion. For a given isotope, the transport time and total experiment time and the optimum number of cycles can be obtained from the plot. (auth)

8773 DETERMINATION OF SILVER IN SILICON BY NEUTRON ACTIVATION AND CHEMICAL SEPARATION BY ISOTOPE EXCHANGE. Zmijewska, W. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 8: No. 5, 285-90(18 Dec 1971).

The isotope exchange of silver on AgCl precipitates was successfully used for the radiochemical separation of this element in the course of its determination in semiconductor grade silicon by neutron activation. (auth)

8774 ACTIVABLE RARE EARTH ELEMENTS AS ESTUARINE WATER TRACERS. Channell, James Kirkpatrick. Stanford, Calif.; Stanford Univ. (1971). 205p. University Microfilms Order No. 71-19,660.

Thesis.

A post-sampling neutron activation analysis method was developed for the use of stable rare earth elements (REE) as external tracers in estaurine waters. The REE have low concentrations in seawater, favorable activation and induced-radioactivity properties, and homologous chemical behavior. Estuarine water samples are prepared for activation by filtration, coprecipitation of the REE group with $Fe(OH)_3$, passing the dissolved precipitate through an anion exchange column, and reprecipitation of the elutant with $Fe(OH)_3$. Following activation, the REE are retained on a cation exchange column while the remaining contaminants are eluted. Radioactive ^{140}La and ^{152}Eu are measured by γ scintillation spectroscopy with a sodium iodide crystal detector. Detection limits of 1 ng for europium and 20 ng for lanthanum are achievable with the activation and measuring system used. The REE are suited for tracing water movement in deeper waters and in the dissolved, suspended, and settleable solids phases of sewage effluent. They are least suitable for water tracing in shallow water and in areas where significant deposition and resuspension of suspended solids occur. The cost of activable lanthanum tracer and analyses is competitive with the radiotracer ^{140}La for sewage tracing in large studies and avoids use of hazardous amounts of radioactivity. Lanthanum is less expensive than Rhodamine WT dye for tagging volumes of water in excess of 10 million acre feet (MAF). Tritium may be less expensive than lanthanum for volumes above 10 MAF and may be preferable for water tracing if its use is radiologically acceptable. Tritium and lanthanum could be used as multiple tracers in a single study. Europium is not economically competitive. (Diss. Abstr. Int., B)

8775 NEITRONNOAKTIVATSIONNYI ANALIZ. (Neutron Activation Analysis). Lobanov, E. M. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1971). 192p.

This manual is a collection of 19 papers by various authors who describe the determination of a number of elements in specific types of samples, such as minerals, soils, and biological samples as human blood, organs, and tissues. Methods of neutron activation are presented for the following elements: Au, Hf, U, Th, Sc, La, Ce, Sm, Nd, Ta, Cs, O, Na, Sb, Br, Sr, Ba, Fe, Ag, D, Se, Al, as well as several short-lived isotopes. Selected references are placed at the end of each paper. (K.S.W.)

8776 SPRAVOCHNIK PO NEITRONNOMU AKTIVATSIONNOMU ANALIZU. (Neutron Activation Analysis Handbook). Maslov, I. A.; Luknitskii, V. A. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1971). 312p.

This reference work lists nearly 1,500 cross sections for nine types of nuclear reactions induced by neutron interaction, data on the spectra of gamma emitters, and tables for their identification. An appendix presents methods of 14-MeV neutron flux measurements from the Texas Convention (1965). Various types of errors resulting from neutron activation determinations are discussed at length. (K.S.W.)

8777 NEUTRON-ACTIVATION SCHEME DEVELOPED FOR THE DETERMINATION OF 42 ELEMENTS IN LUNAR MATERIAL. Brunfelt, A. O. (Univ. of Oslo); Steinnes, E. Talanta; 18: No. 12, 1197-1208(Dec 1971).

A neutron-activation scheme designed for the determination of 42 elements in lunar rocks and fines is described. The scheme is based on seven different irradiations, four of which are followed by direct γ spectrometry, and three by radiochemical separation systems. The total sample consumption for duplicate analysis is about 800 mg. The scheme was tested on basalt BCR-1, and results for this standard rock are presented. Analytical experience obtained from analyses of lunar samples and BCR-1 is discussed. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 8878, 9688, and 10018.

8778 ABSTRACTS OF PAPERS. 162nd National Meeting, American Chemical Society, Washington, D. C., September 12–17, 1971. Washington, D. C.; American Chemical Society (1971). 983p. $6.00. (CONF-710913-(Absts.)).

Chemical Properties

Refer also to abstracts 9046, 9048, and 9060.

8779 (CONF-690426) SYMPOSIUM ON THE TRANSURANIUM ELEMENTS, LIEGE, BELGIUM, 21–22 APRIL 1969. (Institut Interuniversitaire des Sciences Nucleaires, Brussels (Belgium). Liege Univ. (Belgium). European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). 255p. (In English and German).

Separate abstracts were prepared for 14 of the 15 papers presented. An abstract of the remaining paper appeared as NSA 23: 47585. (D.H.M.)

For abstracts of individual papers see: 8780–8785, 8859, 8860, 8974, 8975, and 8999–9002.

8780 (CONF-690426–, pp 3-20) CURRENT RESEARCH ON ACTINIDE ELEMENT CHEMISTRY AT BERKELEY. Cunningham, B. B. (California Univ., Berkeley. Lawrence Radiation Lab.). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

The research now in progress at Berkeley is discussed under three general headings: oxidation–reduction behavior of the actinides; properties of the actinide metals; and work with actinide isotopes of very high specific activity. A brief report is also presented on recent research on the synthesis and identification of element 104. (D.H.M.)

8781 (CONF-690426–, pp 30-53) RECENT WORK ON THE SOLUTION CHEMISTRY OF TRI-AND TETRAVALENT AMERICIUM. Marcus, Y. (Hebrew Univ., Jerusalem (Israel)). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

A study was made of the reactions of trivalent americium with carbonate, nitrate, chloride, and bromide anions. The production of tetravalent americium by oxidizing trivalent americium electrolytically in phosphoric acid is also reported. (D.H.M.)

8782 (CONF-690426–, pp 152-68) RECENT PREPARATIVE CHEMISTRY AT HARWELL. Brown, D. (Atomic Energy Research Establishment, Harwell (England)). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

Results are reported on the preparation and properties of neptunium, thorium, protactinium, uranium oxyhalides, lanthanide and actinide tribromide hexahydrates, americium(III) chloro complexes, octafluoroneptunates, and tetravalent actinide and trivalent actinide and lanthanide chelates with diethyldithiocarbamates. (D.H.M.)

8783 (CONF-690426–, pp 192-202) CURRENT RESEARCH ON TRANSURANIUM ELEMENTS AT THE NUCLEAR PHYSICS INSTITUTE IN PARIS AND ORSAY. Pages, Monique (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

Current research on transuranium elements at the Nuclear Physics Institute in Paris and Orsay is reported in the following areas: studies in aqueous and non-aqueous solutions; studies in the solid state; calculations on the ground state of lanthanides and actinides; and the search for super heavy transuranium elements. (D.H.M.)

8784 (CONF-690426–, pp 203-12) AMINOCARBOXYLIC ACID COMPLEXES OF THE ACTINIDES. Eberle, S. H. (Karlsruhe Univ. (West Germany)). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

A study of the complex formation between aminopolycarboxylic acids and tri- and pentavalent actinide elements is reported. As a

rule, these complexes are characterized by their composition and their stability constants. Of specific interest is the dependency of stability on the structure of the ligand and the constitution of the complexes. As far as possible spectrophotometry was used for the investigations. It shows the formation of coordination compounds of the actinides directly through the appearance of new absorption peaks, the inaccuracy of the extinction measurements causing only minor errors or none at all. Where this type of optical measurement is not possible, the ion exchange method was applied. All stability constants are calculated on a computer by least square fit. (auth)

8785 (CONF-690426–, pp 246-55) CYCLOPENTADIENYL: COMPLEXES OF THE ACTINIDE ELEMENTS. Kanellakopulos, Basil (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

Methods for the synthesis of the following cyclopentadienyl complexes are reported: uranium, neptunium, plutonium, rare earths, protactinium, and americium. The physical properties, NMR studies, ESR studies, molecular structure, magnetic susceptibility measurements, and chemical bonding of the complexes are also discussed. (D.H.M.)

8786 (MLM–1870) PLUTONIUM IN NATURAL WATERS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). 16 Dec 1971. Contract AT-33-1-Gen-53. 15p. Dep. NTIS.

A method for estimating the concentrations of soluble trivalent, tetravalent, pentavalent, and hexavalent plutonium in natural waters is illustrated with a small computer program and two examples. The program, which requires the potential and pH of natural waters, may also be used to approximate the proportion of the plutonium that is present as polymer in equilibrium with the soluble plutonium. (auth)

8787 (ORNL–4706, pp 113-18) ORGANIC CHEMISTRY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

Research progress is reported on organic chemistry in the following areas: preparation of vinyl esters; deamination of 1-cyclopentylethylamine; solvolysis of 3-phenyl-2-bromopropanol; mechanisms of the Diels–Alder reaction (attempts to prepare unusual hydrocarbons); heats of formation of 3-aryl-2, 3-dimethyl-2-butyl cations in super acids; the mechanism of hydride shift in norbornyl cations; deuterium tracer study of 6, 1,2-hydride shift in substituted norbornyl cations; preparation and purification of p-sexiphenyl. (D.H.M.)

8788 OXIDATION OF 1-BUTENE OVER UO_3–Sb_2O_3 CATALYSTS. Simons, G. J.; Houtman, P. N.; Schuit, G. C. A. (Univ. of Tech., Eindhoven, Netherlands). J. Catal.; 23: 1-10(Oct 1971).

The oxidative dehydrogenation of butene to butadiene over U–Sb catalysts was investigated. The presence of two compounds, reported by Grasselli and Callahan, was confirmed with one being the actual catalyst. The reaction is first order in butene and zero order in oxygen. In the absence of oxygen, interaction of butene with the catalyst oxygen occurred but only to a minor degree, the interaction being confined to the surface. Partial reactivation by heating of a catalyst inactivated by the interaction with butene in the absence of O_2 could be effected, but there exists a tendency for the catalyst to decompose. A remarkable detail in the kinetics is that, contrary to the reaction over Bi–Mo catalyst, double-bond isomerization is absent. (auth)

8789 ELECTROCHEMICAL BEHAVIOR OF TECHNETIUM AND IRON CONTAINING TECHNETIUM. Cartledge, G. H. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc.; 118: No. 11, 1752-8(Nov 1971).

The electrochemical behavior of pure technetium and iron containing 0.1 wt % technetium was determined by polarization in sulfuric acid. Evolution of hydrogen on technetium has a Tafel slope approximating –40 mV/decade. At overvoltages noble to the hydrogen-evolution potential, oxidation of technetium of its surface oxides has a rate of ca 10^{-6} A/cm^2 until the potential becomes high enough to form soluble pertechnic acid. The current density then rises rapidly. The presence of technetium in iron modifies the electrochemical behavior because dissolution of iron leads to enrichment of the surface in residual technetium. This causes the open-circuit potential to ennoble, with lowering of the overvoltage for evolution of hydrogen. Passivation is also rendered more difficult and much less effective in lowering the passive corrosion current density. (auth)

8790 FORMATION CONSTANTS OF SOME BIVALENT METAL ION CHELATES OF N(2-HYDROXY-1-NAPHTHALIDENE) ANTHRANILIC ACID (SCHIFF BASE). Mehta, R. K.; Singhi, V. C.; Gupta, R. K. (Univ. of Jodhpur, India). Z. Naturforsch.; 26b: No. 9, 867-9(Sep 1971).

Protonation constants (log K_1^H and log K_2^H) of the Schiff base derived from 2-hydroxyl-1-naphthaldehyde and anthranilic acid and the formation constants of certain divalent metal ion chelates were determined potentiometrically in 50% (vol./vol.) dioxane solutions (μ = 0.1 M $NaClO_4$). The stabilities of these metal chelates are in the order, UO_2 > Cu > Ni > Co > Zn > Cd, in which the sequence of those of first transitional metal ion chelates are in agreement with Irving and Williams order. (auth)

8791 DETERMINATION AND COMPARISON OF THE STABILITY CONSTANTS OF SOME BIVALENT ION COMPLEXES OF 5,7-DICHLORO-, 5,7-DIBROMO-, AND 5,7-DINITRO-8-HYDROXYQUINOLINE AND THEIR N-OXIDES. Gupta, R. D.; Manku, G. S.; Bhat, A. N.; Jain, B. D. (Univ. of Delhi). Z. Anorg. Allg. Chem.; 379: No. 3, 312-19(Dec 1970).

The stability constants of complexes of Mn^{2+}, Fe^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, and UO_2^{2+} with 5.7-dichloro-, 5,7-dibromo- and 5.7-dinitro-8-hydroxyquinoline and their corresponding N-oxides were determined in 75 + 25 v/v dioxane + water medium at 35°C in the presence of 0.20 M sodium perchlorate by pH-titration technique as given by Irving and Rossotti. A possible explanation for the observed orders of the stability constants of the metal complex with the different ligands and of the complexes of a particular ligand with different metal ions is also proposed. (auth)

8792 TERNARY COMPOUND IN THE U–N–Cl SYSTEM. Yoshihara, K.; Yamagami, S.; Kanno, M.; Mukaibo, T. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 33: No. 10, 3323-9(Oct 1971).

A ternary compound UNCl was prepared by the reaction of uranium chlorides with aluminium or silicon and nitrogen. The chemical composition of UNCl was determined by chemical analyses. The crystal structure of UNCl was determined by x-ray analysis. From the relative line intensities of x-ray diffraction of UNCl, Patterson function was calculated by means of the computer code UNICS. From this calculation, the configuration of atoms in the crystal of UNCl was deduced. (auth)

8793 CITRIC COMPLEXES OF 4f AND 5f ELEMENTS. Guillaumont, Robert; Bourderie, Lucette (Paris Univ., Orsay, France). Bull. Soc. Chim. Fr.; No. 8, 2806-9(Aug 1971). (In French).

The formation of citric complexes of Eu, Gd, Tb, Am, Cm, Cf ($2.5 < pH < 5.5$; C_{H3} cit < 2×10^{-2}M) demonstrates that these elements behave differently under the same experimental conditions. The values of the equilibrium constants were determined in media of ionic strength 0.1 using the solvent extraction method by chelate formation. (France)

8794 OXYGEN DECOMPOSITION PRESSURES AND THERMODYNAMIC DATA FOR NONSTOICHIOMETRIC BERKELIUM OXIDE. Turcotte, R. P. (Battelle-Northwest, Richland, Wash.); Chikalla, T. D.; Eyring, L. J. Inorg. Nucl. Chem.; 33: No. 11, 3749-63(Nov 1971).

A unique, highly sensitive system for quantitative measurement of decomposition pressures of small samples was used to obtain equilibrium oxygen decomposition pressures over a 1.22 mg sample of nonstoichiometric ^{249}Bk oxide. The temperature and pressure range investigated was 852 to 1150°C and from 10^{-7} to 10^{-20} atm O_2, respectively. These conditions were sufficient to enable examination of nearly the entire compositional range between BkO_2 and Bk_2O_3. Partial thermodynamic quantities were derived and found to be a function of composition but independent of temperature. The shapes of the equilibrium decomposition pressure isotherms were used to deduce the possible condensed phase relationships in this oxide system. (auth)

8795 APPARATUS FOR THE CONTINUOUS PRECIPITATION OF PLUTONIUM OXALATE. Arnal, Thierry; Ganivet, Michel; Somon, Roland (to Commissariat a l'Energie Atomique). French Patent 2,060,243. 18 Jun 1971. Filed 19 Sep 1969. (In French).

A precipitation system is described: solutions of Pu nitrate and oxalic acid are fed into the upper part, and a decanter beneath the mixer collects the precipitate leaving the precipitator. A washing column, which is divided into two sections, is situated at the lower part of the decanter. The washing solutions that enter at the lower part of these sections are evacuated from the upper part of the decanter. The apparatus also possesses an exit chamber and a filtering cartridge in which the precipitate is dried. (France)

8796 EXISTENCE OF URANYL–PERIODIC COMPLEXES, ANALYTICAL APPLICATIONS. Hutin, M. F. (Univ., Nancy). Compt. Rend., Ser. C: 273: No. 13, 739-40(27 Sep 1971). (In French).

When an excess of IO_4^- ions is present for pH values ≥2, the reaction of monosodium periodate with a uranyl nitrate solution induces the formation of a weak diuranyl-periodic acid: $H(UO_2)_2IO_6$. When there is an excess of IO_4^- ions and for all pH values, the monouranyl-periodic $(UO_2IO_6)^{3-}$ anion is formed. The first complex $HIO_6(UO_2)_2 \cdot 8H_2O$ and the salts of the second complex, $Na(H_2UO_2IO_6) \cdot 7H_2O$ and $Ba(H_2UO_2IO_6)_2$, were investigated. (France)

8797 ACIDITY CHANGES IN DILUTE PERCHLORIC ACID THROUGH ADDITION OF URANYL OR ALUMINUM SALTS. Kalman, E.; Allies, M. (Technische Univ., Dresden). Z. Phys. Chem. (Leipzig); 245: No. 5-6, 425-30(1970). (In German).

The pH values of perchloric acid solutions of $AlCl_3$, $Al(ClO_4)_3$, UO_2SO_4, UO_2Cl_2, $UO_2(NO_3)_2$, and $UO_2(ClO_4)_2$ are given in relation to concentration. The pH shifts at differing concentrations of the same salts are discussed. The pH shift corresponds to changes in activity coefficients of the salt in relation to concentration. (M.C.G.)

8798 PREPARATION OF URANIUM PHOSPHIDE FROM URANIUM TETRAFLUORIDE. Ono, Futaba; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 553-7(Oct 1971).

A study was made on UP preparation by two-step reactions starting with UF_4, Si, and red phosphorus. The first step was to produce an intermediate uranium phosphide, U_3P_4, from the reaction of UF_4 with Si under phosphorus vapor at temperatures above 900°C. In the second step, the intermediate phosphide was heat-treated under vacuum. To obtain single phase UP from the intermediate phosphide, the treatment required a temperature above 1,050°C, at which temperature the minimum holding time was 60 min. (auth)

8799 COORDINATION CHEMISTRY AND PHYSICAL PROPERTIES OF TRANSPLUTONIUM ACTINIDE COMPOUNDS. Cunningham, Burris B. (Univ. of California, Berkeley). Pure Appl. Chem.; 27: No. 1-2, 43-60(1971).

Physical properties of the actinide elements that influence their coordination chemistry are discussed and compared with the same properties in other d and f transition elements. Properties considered include oxidation states, ionic radii, spin-pairing energies, use of f orbitals in bonding and ligand field interactions. The coordination properties of the actinide elements are found to be a logical consequence of their position in the periodic system. (80 references) (auth)

8800 DEVELOPMENT OF COORDINATION CHEMISTRY IN THE SOVIET UNION. Spitsyn, V. I. (Moscow State Univ.). Pure Appl. Chem.; 27: No. 1-2, 193-225(1971).

A review is presented of the most important work on coordination chemistry carried out in the Soviet Union during the past decade, including the coordination chemistry of the actinides. It is stated that in the past two years more than 200 new coordination compounds of Th were synthesized and studied, and it was conclusively proved that Th has no fixed coordination number, and that this can vary even within one class of compounds from 8 to 12 or even higher. Some of these Th compounds are discussed. With regard to the U compounds the coordination number has been found to be four, five, or six; some examples of each of these are given. The coordination compounds formed in U extraction by organic solvents are briefly discussed, and brief mention is made of the coordination chemistry of Np and Pu, and also of the rare earths, Be, B, Zr, Hf, etc. (148 references) (UK)

8801 KINETICS AND MECHANISM OF THE OXIDATION OF Pu(IV) BY Ce(IV) IN SULPHATE AND NITRATE MEDIA. Ekstrom, A.; McLaren, A. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Inorg. Nucl. Chem.; 33: No. 10, 3511-20(Oct 1971).

The oxidation of Pu(IV) by Ce(IV) was studied in the presence of sulphate and nitrate ions. The rate of reaction is strongly inhibited by sulphate ion, being inversely proportional to between the square and cube of the HSC_1^- concentration at a given acid concentration. In the range $10^{-3}-10^{-1}$ M nitrate, the reaction rate is independent of nitrate concentration, but is inversely proportional to the square of the hydrogen ion concentration. Possible reaction mechanisms consistent with the observed data are discussed. (auth)

8802 STABILITY CONSTANTS OF NITRATE AND CHLORIDE COMPLEXES OF Np(IV), Np(V), AND Np(VI) IONS. Danesi, P. R.; Chiarizia, R.; Scibona, G.; D'Alessandro, G. (CNEN, Rome). J. Inorg. Nucl. Chem.; 33: No. 10, 3503-10(Oct 1971).

The formation constants of NpO_2^{2+} and Np^{4+} ions with the Cl^- and NO_3^- ligands were determined by the TTA extraction method in a 4M constant ionic medium. The complexes between NpO_2^{2+} and Cl^- and NO_3^- were evaluated by studying the potential variations of the Np(VI)/Np(V) couple at a platinum electrode as function of the ligand concentration. The data were analyzed by using a suitable computer least squares program. The following formation constants were determined at μ = 4M and T = 25°C: $Np^{4+} + Cl^- \rightleftharpoons NpCl^{3+}$, $\beta_1 = 0.77 \pm 0.06$; $Np^{4+} + 2Cl^- \rightleftharpoons NpCl_2^{2+}$, $\beta_2 = 0.79 \pm 0.06$; $Np^{4+} + NO_3^- \rightleftharpoons NpNO_3^{3+}$, $\beta_1 = 0.7 \pm 0.2$; $Np^{4+} + 2NO_3^- \rightleftharpoons Np(NO_3)_2^{2+}$, $\beta_2 = 0.18 \pm 0.05$; $NpO_2^{2+} + Cl^- \rightleftharpoons NpO_2Cl^+$, $\beta_1 = 0.69 \pm 0.05$; $NpO_2^{2+} + NO_3^- \rightleftharpoons NpO_2NO_3^+$, $\beta_1 = 0.21 \pm 0.03$; $NpO_2^+ + Cl^- \rightleftharpoons NpO_2Cl$, $\beta_1 = 0.003 \pm 0.003$; $NpO_2^+ + 2Cl^- \rightleftharpoons NpO_2Cl_2^-$, $\beta_2 = 0.028 \pm 0.003$; $NpO_2^+ + NO_3^- \rightleftharpoons NpO_2NO_3$, $\beta_1 = 0.025 \pm 0.001$; and $NpO_2^+ + 2NO_3^- \rightleftharpoons NpO_2(NO_3)_2^-$, $\beta_2 = 0.043 \pm 0.001$. (auth)

8803 INVESTIGATION OF Zr(IV), Hf(IV), AND Th(IV) THIOCYANATE COMPLEXES BY EXTRACTION WITH THENOYLTRIFLUOROACETONE AND DINONYL NAPHTHALENE SULPHONIC ACID. Laubscher, A. E.; Fouche, K. F. (Univ. of the Orange Free State, Bloemfontein, South Africa). J. Inorg. Nucl. Chem.; 33: No. 10, 3521-35(Oct 1971).

The stability constants for zirconium, hafnium and thorium thiocyanate complexes were investigated by solvent extraction with dinonylnaphthalenesulphonic acid (HDNNS) and thenoyltrifluoroacetone (TTA). The stability constants for zirconium and hafnium in 2M $HClO_4$ and ionic strength 3 and for thorium in 0.5M $HClO_4$ and ionic strength 3, are: Zr: $\beta_1 = 12.1 \pm 2.2$, $\beta_2 = 215 \pm 11$ and $\beta_4 = 205 \pm 20$; Hf: $\beta_1 = 13.5 \pm 3.3$, $\beta_2 = 215 \pm 17$ and $\beta_4 = 167 \pm 28$; Th: $\beta_1 = 7.12 \pm 1.11$, $\beta_2 = 33.9 \pm 5.3$, $\beta_3 = 14.3 \pm 7.3$ and $\beta_4 = 32.4 \pm 2.7$. Experimental results for the extraction of hafnium reveal that the extraction of positively-charged complexes such as $M(CNS)^{3+}$ and MF^{3+} (M = Zr, Hf) must be considered when calculating stability constants from HDNNS distribution results. (auth)

8804 STUDY OF AMMONIUM PLUTONIUM(IV) FLUORIDES. I. THE PREPARATION OF AMMONIUM PLUTONIUM(IV) FLUORIDES. Muromura, Tadasumi; Yahata, Taneaki; Ouchi, Kinji; Naito, Keiji (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 33: No. 10, 3331-7(Oct 1971).

The preparation of ammonium plutonium(IV) fluorides from the mixed solution of 0 to 10M NH_4F and 0 to 10M HF was studied. The valency of Pu(IV) was adjusted by controlled potential electrolysis or by addition of NH_4NO_2 solution. The precipitates obtained from Pu(IV) adjusted by controlled potential electrolysis were pink $6PuF_4 \cdot 7NH_4F$ (or $PuF_4 \cdot NH_4F$) and green $PuF_4 \cdot 2NH_4F$; the former was precipitated from 0.5 to 2M NH_4F, while the latter from 4 to 10M NH_4F, and mixed precipitates were obtained in the concentration region of 2 to 4M NH_4F. The solubility of plutonium has a minimum at 0.5M NH_4F and then increases rapidly with the concentration of NH_4F. The precipitates obtained from Pu(IV) adjusted by NH_4NO_2 solution were a pink $6PuF_4 \cdot 7NH_4F$ (or $PuF_4 \cdot NH_4F$) and a red new compound showing a different X-ray pattern and $Pu-F-NH_3$ mole ratio 1.0: 5.6 to 5.8: 0.7 to 0.8. (auth)

8805 URANYL (BIS(DITHIOLATE) COMPLEXES WITH PYRIDINE-N-OXIDE, TRIPHENYLPHOSPHINE OXIDE, AND TRIPHENYLARSINE OXIDE AS LIGANDS. Zimmer, L.; Liesser, K. H. (Technische Hochschule, Darmstadt, Ger.). Inorg. Nucl. Chem. Lett.; 7: No. 12, 1163-8(Dec 1971). (In German).

The tetraethylammonium and tetrapropylammonium salts of UO_2T_2L were prepared (T = maleonitriledithiolate, isomaleonitriledithiolate, or diethyldithiocarbamate; L = pyridine-N-oxide, triphenylphosphine oxide, or triphenylarsine oxide). Their stability, crystallization, and solubility in various solvents are briefly mentioned. Color, melting point, conductance, and confirmatory elemental analyses are tabulated. The conductivity measurements show them to be ternary electrolytes. A pentagonal, bipyramidal structure is suggested for the complexes, in which the uranyl ion is perpendicular to an axis of four sulfur atoms and one oxygen atom. The results of absorption spectral studies (infrared, visible, and ultraviolet) and the coordination chemistry of the uranyl ion, as revealed by these complexes, are briefly discussed. (UK)

8806 DIOXOURANIUM(VI) COMPLEXES OF SOME ACYLHYDRAZINES. Aggarwal, R. C.; Prasad, B. (Banaras Hindu Univ., India). J. Inorg. Nucl. Chem.; 33: No. 11, 3984-8(Nov 1971).

A description is given of the preparation and some physical properties of dioxouranium(IV) complexes of acylhydrazines such as acetylhydrazine (AH), benzoylhydrazine (BH), salicyloylhydrazine (SH), acetylbenzoylhydrazine (ABH), diacetylhydrazine (DAH), and diformylhydrazine (DFH), of the types $UO_2(NO_3)_2 \cdot 2L \cdot 2H_2O$ and $UO_2(NO_3)_2 \cdot 2L$ (where L = BH, DAH, SH, or ABH), $UO_2(NO_3)_2 \cdot 3AH$, $UO_2Cl_2 \cdot 3BH$, and UO_2 (DFH-2H). Molar conductance and infrared studies indicated the presence of coordinated nitrate in these complexes. This is thought to be the first work on these compounds. A full account is given of the experimental work, together with a discussion of the results. (UK)

8807 AMERICIUM(III) AND EUROPIUM(III) COMPLEXES WITH LACTATE, PYRUVATE, AND α-ALANINATE IN AQUEOUS SOLUTIONS: A COMPARISON OF EQUILIBRIUM CONSTANTS. Aziz, A.; Lyle, S. J. (Univ. of Kent, Canterbury, Eng.). J. Inorg. Nucl. Chem.; 33: No. 10, 3407-8(Oct 1971).

Equilibrium constants for americium(III) in its interactions with lactate, pyruvate, and the zwitterion from α-alanine are presented and compared with corresponding values (previously reported as free-energy changes) for europium(III). As for those with europium(III) the measurements were carried out at 25°C in a sodium perchlorate medium, ionic strength 2, using a partition method. (auth)

8808 CHEMISTRY OF THE URANYL GROUP. PREPARATION AND CRYSTAL AND MOLECULAR STRUCTURE OF BIS(N,N-DIETHYL DISELENOCARBAMATE)DIOXO(TRIPHENYLARSINE OXIDE)URANIUM(VI). $UO_2[Et_2NCSe_2]_2Ph_3AsO$. Zarli, B. (Univ., Padua); Graziani, R. J. Chem. Soc., D; No. 23, 1501-2(8 Dec 1971).

Two complexes of formula $UO_2(Et_2NCSe_2)_2 \cdot L$ (L = Ph_3PO or Ph_3AsO) were prepared; the arsine oxide derivative is a pentagonal-bipyramidal complex, the four selenium atoms and the ligand oxygen atom lying in the plane normal to the uranyl group. (auth)

8809 SYNTHESIS OF URANIUM CARBONYLS USING MATRIX ISOLATION. Slater, J. L. (Florida State Univ., Tallahassee); Sheline, R. K.; Lin, K. C.; Weltner, W. Jr. J. Chem. Phys.; 55: No. 10, 5129-30(15 Nov 1971).

Attempts were made to prepare the uranium carbonyls directly from the metal and carbon monoxide in an argon matrix. The matrix was prepared by condensing 99.8% U metal into a dilute CO–Ar matrix at 4°K. The matrix was then allowed to warm up a few degrees and then was quenched to 4°K. Infrared spectra were used to identify a number of uranium carbonyls, which were stable up to 30°K. (M.C.G.)

8810 CHEMICAL PROPERTIES OF URANIUM COMPOUNDS IN THE MOLTEN LiCl–KCl EUTECTIC. Landresse, G.; Duyckaerts, G. (Univ., Liege). Anal. Chim. Acta; 57: No. 1, 214-16(Nov 1971). (In French).

The behavior of uranium and its compounds in the molten LiCl–KCl eutectic was studied by examining individual reactions that take place in the system. In the molten eutectic, uranium exists in the oxidation states U(III), U(IV), UO_2(V), and UO_2(VI) in the form of complex chlorides. Spectrophotometric studies were conducted on the reactions of UO_2(VI) and UO_2(V) with hydrogen and U(IV) with hydrogen and oxygen. The reactions of UO_2(V), UO_2(VI), and UO_2 with gaseous HCl were also studied. (J.G.B.)

8811 NEW SCHEELITE TYPE Np COMPOUND: $Li_4Np(MoO_4)_4$. Pages, Monique; Freundlich, William (Univ., Paris). Compt. Rend., Ser. C; 273: No. 6, 459-61(9 Aug 1971). (In French).

An investigation of the $Np(MoO_4)_2$–Li_2MoO_4 system led to the identification of a new NP(IV) compound: $Li_4Np(MoO_4)_4$ having a scheelite superstructure and isotype with $Na_4Np(MoO_4)_4$. This compound melts congruently at 647°C. (France)

8812 ELECTROPHORETIC BEHAVIOR OF THORIA IN NITRIC ACID. Smith, F. J.; Krohn, N. A. (Oak Ridge National Lab., Tenn.). J. Colloid Interface Sci.; 37: No. 1, 179-85(Sep 1971).

Studies were made of the electrophoretic behavior of five different thoria sols at 20°C, using a moving-boundary technique. At ionic strengths of the intermicellar fluid (HNO_3 or $HNO_3 + NH_4NO_3$; pH range of 2.5 to 3.5) of about 0.0003 and 0.003, two or more electrophoretic bands were observed; however, only one band was found when the ionic strength was 0.01. It was shown that the existence of multiple bands was not due to inhomogeneity of thoria particles in the sols. The results were interpreted in terms of moving-boundary theory for strong electrolytes by assigning a true boundary to thoria and attributing the other boundaries to charged species such as Th^{4+} that were present in the intermicellar fluid. Zeta potentials ranging from 27 to 53 mv were calculated for the five sols in an intermicellar fluid of HNO_3 (pH = 2.0; ionic strength = 0.01). At constant ionic strength, the zeta potentials increased slightly with increasing pH. (auth)

8813 INVESTIGATION OF FAST MATTER TRANSPORT PROCESSES IN CHEMICAL REACTORS. Runge, K.; Geyer, H. (Technische Univ., Dresden). Isotopenpraxis; 7: No. 6, 220-3(Jun 1971). (In German).

Problems of labeling and metering techniques involved in investigations of fast matter transport processes in chemical reactors are discussed. Examples are quoted to show how these problems were solved. Methyl bromide (^{82}Br) and xenon (^{133}Xe) were used to label the gaseous phase of gas–solid fluidized beds. The solids of an airborne dust cloud were labeled with ^{24}Na. The hold-up-time spectra were measured with the aid of a measuring device developed especially to carry out these investigations. In all investigations, mean hold-up-time values of the matters proved to be in the seconds range. (auth)

8814 POTENTIOMETRIC STUDIES OF COMPLEX IONS: RELATIVE STABILITIES OF DIVALENT IONS UO_2^{2+}, Be^{2+}, AND Cu^{2+} WITH OXYGEN DONOR LIGANDS. Mahadevan, N.; Shetty, S. Y.; Sathe, R. M. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 3, 258-60(Mar 1971).

The stability constants in aqueous and water–dioxane media of the chelates of the three divalent ions, UO_2^{2+}, Be^{2+}, and Cu^{2+}, with a large number of oxygen donor ligands capable of forming five- or six-membered chelate rings were compared to see whether the Basolo–Pearson order $UO_2^{2+} > Be^{2+} > Cu^{2+}$ is valid. By and large, the Basolo–Pearson order with respect to these ligands was found to be valid. The deviations encountered are ascribable to steric and resonance factors. (auth)

Isotope Effects and Exchange

Refer also to abstracts 8773, 8894, 9030, 9036, 9050, 10050, and 10101.

8815 HYDROGEN EXCHANGE REACTION BETWEEN BENZENE AND PERDEUTERIOBENZENE CATALYZED BY EVAPORATED METAL FILMS. Moyes, R. B.; Baron, K.; Squire, R. C. (Univ. of Hull, Eng.). J. Catal.; 22: No. 3, 333-9(Sep 1971).

The hydrogen exchange reaction between benzene and perdeuteriobenzene at 0°C was investigated using evaporated films of molybdenum, rhodium, palladium, silver, tantalum, tungsten, rhenium, iridium, and platinum. The reaction occurs readily over all of these metals, but over platinum and palladium the expected equilibrium is not attained. This is interpreted in terms of poisoning of the catalyst with strongly adsorbed material. There is no reaction over gold. The rate constants for the reaction show a linear relationship with the percentage d character of the metallic bonds. The reaction is thought to occur through the formation of dissociatively adsorbed species on the metal surface in those cases where reaction occurs readily. Associatively adsorbed species may account for the anomalous features of the reaction on palladium and on platinum. (auth)

8816 KINETIC STUDY OF THE ^{15}N EXCHANGE OF PARA-SUBSTITUTED BENZAMIDES WITH AMMONIA. Everly, Charles R.; Fry, Arthur (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3234. J. Org. Chem.; 36: No. 23, 3587-90 (19 Nov 1971).

A kinetic study was carried out on the nitrogen-15 exchange of para-substituted benzamides-^{15}N with liquid ammonia as a function of temperature and catalyst concentration. Neither a neutral nor a base-catalyzed exchange pathway is detectable under the conditions employed. The relative rates for the acid-catalyzed (ammonium chloride catalyzed) exchange of the para-substituted benzamides at 40° in the presence of 3M ammonium chloride are $NO_2 : Cl : H : CH_3 : CH_3O = 8.78 : 2.13 : 1.00 : 0.55 : 0.44$. Hammett plots are linear with $\rho = +1.25$. The kinetic data indicate a first-order dependence of the exchange rate on the ammonium ion concentration. All of the reactions exhibit pseudo-first-order kinetics. The trends in the kinetic data are what would be expected for an exchange mechanism involving a rapid preequilibrium protonation of the amide followed by a slow rate-determining addition of ammonia to form a tetrahedral intermediate, which can revert to reactants or decompose to products depending upon which nitrogen is lost. (auth)

8817 ALKALINE AMIDE SOLUTIONS IN AMINES. ISOTOPIC EXCHANGE WITH MOLECULAR HYDROGEN. Rochard, Elisabeth; Ravoire, Jean (CEN de Saclay, Gif-sur-Yvette, France). J. Chim. Phys.; 68: No. 7, 1183-91(Jul 1971). (In French).

The kinetics of the isotopic exchange between hydrogen and methylamine (MMA), isopropylamine (IPA), and dimethylamine (DMA), catalyzed by their corresponding potassium amides, were investigated. The exchange rates were measured at three temperatures for catalyst concentrations up to 10^{-1} mole l^{-1}; they are in the following sequence: v(DMA) > v(MMA) > v(IPA). The activation energies E_a(MMA), E_a(IPA), and E_a(DMA) are 6.8 ± 0.5, 6.5 ± 1, and 7.0 ± 0.5 kcal $mole^{-1}$, respectively. The activation entropies ΔS(MMA), ΔS(IPA), and ΔS(DMA) are −5 ± 2, −12 ± 3, and 2 ± 2 cal d^{-1} $mole^{-1}$. Ion pairs K^+NHR^- or $K^+NR_2^-$ appear to be the main catalytic species. (France)

8818 USE OF DEUTERIUM ISOTOPE EFFECTS IN ESTABLISHING MASS SPECTRAL FRAGMENTATION MECHANISMS. Howe, Ian; Williams, Dudley H. (Cambridge Univ., Eng.). J. Chem. Soc., D; No. 19, 1195-7(6 Oct 1971).

Isotope effects on competing metastable transitions were employed to show that elimination of ethylene from the molecular ion of p-bromophenetole proceeds via a 4-membered transition state. (auth)

8819 MECHANISM AND INVERSE PRIMARY KINETIC ISOTOPE EFFECT IN THE REACTION OF FLUORENYLIDENE WITH 3-DEUTERIOCYCLOHEXENE. Baldwin, John E.; Andrist, A. Harry (Univ. of Oregon, Eugene). J. Chem. Soc., D; No. 23, 1512-13(8 Dec 1971).

The 3-(9′-fluorenyl)cyclohexene produced from the reaction of fluorenylidene with cyclohexene is formed by way of the fluorenyl–cyclohexenyl geminate radical pair; for the hydrogen abstraction leading to this radical pair, $k_H/k_D \simeq 0.78$. (auth)

8820 RADIATIVE AND RADIATIONLESS TRANSITIONS IN SOLUTIONS OF RARE EARTH IONS: VIBRATIONAL COUPLING OF H_2O AND D_2O TO ELECTRONIC LEVELS OF Gd^{3+}. Haas, Y.; Stein, G. (Hebrew Univ., Jerusalem). Chem. Phys. Lett.; 11: No. 1, 143-5(15 Sep 1971).

The vibronic satellites due to coupling with OH or OD vibrations of the 312 nm fluorescent emission line from the $^6P_{\frac{7}{2}}$ excited level of Gd^{3+} in aqueous solution of the perchlorate salt were observed. In H_2O the shifts correspond to the OH stretching (and H_2O bending) frequencies, with correspondingly decreased shifts in D_2O. The connection with radiationless transitions is discussed. (auth)

8821 EXPERIMENTAL POTENTIAL ENERGY CURVES FOR $X^2\Pi$ AND $^2\Sigma^+$ STATES OF HF^+. Berkowitz, J. (Argonne National Lab., Ill.). Chem. Phys. Lett.; 11: No. 1, 21-6(15 Sep 1971).

The photoelectron spectra of HF and DF were obtained with a cylindrical-mirror analyzer, using the He 584 Å and Ne 736 Å lines as incident radiation. The four vibrational bands observed corresponding to the $^2\Sigma^+$ state of HF^+, clearly demonstrate that the dissociation energy of HF cannot be significantly less than ca. 5.86 eV and hence that $D_0(F_2) \approx 1.59$ eV. The DF data corroborate the HF results. The data were treated to derive ω_e, $\omega_e x_e$, D_e, and r_e for both $X^2\Pi$ and $^2\Sigma^+$ states of HF^+, and an estimate of the $^2\Pi_{\frac{1}{2}} - {}^2\Pi_{\frac{3}{2}}$ splitting was deduced. These results are discussed in the light of recent ab initio calculations on this system. (auth)

8822 HYDROGEN–DEUTERIUM EXCHANGE AT LOW TEMPERATURES. Savchenko, V. I.; Boreskov, G. K.; Gorodetskii, V. V. (Inst. of Catalysis, Novosibirsk, USSR). Kinet. Katal.; 12: No. 3, 766-9(May-Jun 1971). (In Russian).

An attempt was made to determine the effect of the adsorption of atomic hydrogen on the surface of a nickel film by means of the rate of H_2-D_2 exchange over the temperature range 78 to 400°K. Between 140 and 150°K a sharp discontinuity occurred in the log rate vs 1/T plot, which revealed an abrupt increase in the activation energy of the exchange reaction. Further experiments indicated that the adsorption of atomic hydrogen on nickel did not increase the H_2-D_2 exchange rate, but after heating the film and reducing its activity, adsorption of atomic hydrogen restored the initial activity. (K.S.W.)

8823 DEUTERIUM ISOTOPE EFFECT IN CHLORAMPHENICOL ACTION. Kutter, Eberhard; Machleidt, Hans (Thomae-Research Labs., Biberach, Ger.). J. Med. Chem.; 14: No. 10, 931-4(1971).

α-Deuteriochloramphenicol was synthesized and its activity against Escherichia coli was tested in comparison with chloramphenicol itself. α-Deuteriochloramphenicol had only approximately 80% of the chloramphenicol activity. This finding supports the hypothesis that the benzylic C–H bond is broken in the kinetically determining step of chloramphenicol action. This is consistent with the idea that the antibiotic blocks an enzyme covalently. (auth)

8824 VIBRATIONAL SPECTRA AND STRUCTURE OF DIMETHYLAMINODICHLOROPHOSPHINE. Durig, J. R.; Casper, J. M. (Univ. of South Carolina, Columbia). J. Phys. Chem.; 75: No. 25, 3837-43(9 Dec 1971).

The infrared spectra of dimethylaminodichlorophosphine and dimethylaminodichlorophosphine-d_6 were recorded from 4000 to 33 cm^{-1} in the gas and solid phases. The Raman spectra of the liquid and solid phases for both compounds were also recorded. The spectra were consistent with the presence of only one isomer over the range of phases and temperatures studied. Available experimental data were discussed in connection with the spectra, and it is concluded that the molecule exists in the gauche conformer with the PNC_2 portion of the molecule planar. A vibrational assignment is proposed for the molecule. (auth)

8825 MECHANISM AND KINETICS OF ISOTOPIC EXCHANGE IN ZEOLITES. II. EXPERIMENTAL DATA. Brown, L. M.; Sherry, H. S. (Mobil Research and Development Corp., Princeton, N. J.). J. Phys. Chem.; 75: No. 25, 3855-63(9 Dec 1971).

The kinetics of isotopic exchange of sodium ions in synthetic hydrated zeolites NaX and NaA were investigated by means of a radioactive-tracer technique. Exchange in these zeolites consisted of two observable steps involving structurally distinct cations. The experimental data were interpreted in terms of a new model containing two adjustable parameters representing the rate coefficients of the fast and slow isotopic exchange steps. The model assumes the rate-controlling processes are diffusion in the fast isotopic exchange of mobile ions and intracrystalline exchange (assumed to be first order) between bound and mobile ions in the slower isotopic exchange of bound ions. The behavior of NaX, in which bound and mobile ions in the large cages undergo isotopic exchange in a single apparent diffusional process, is explained by assuming that intracrystalline exchange is at least as fast as diffusion. A rigorous test of the model for zeolite X shows that the rate of the fast step varies inversely with the square of the mean equivalent radius of the crystals and that the rate of the slow step was independent of the size of the crystals, as required mechanistically. Best values of the diffusivities and specific rates of exchange were derived from least-squares fits of the data on the model by use of the known distributions of cations over the different kinds of sites. (auth)

8826 DEUTERIUM SOLVENT ISOTOPE EFFECTS IN METHANOL SOLUTION. PART II. THE GENERAL ACID-CATALYSED REACTION OF CYANOKETEN DIMETHYL ACETAL WITH SOLVENT. Gold, V.; Grist, S. (London Univ.). J. Chem. Soc., B; No. 11, 2272-81(1971).

The kinetics of the acid-catalyzed reaction of cyanoketen dimethyl acetal in methanol solution, involving addition of solvent to the olefinic double bond of the substrate, were studied by spectrophotometry at 24.8°C. Catalysis by dilute strong mineral acid (hydrochloric acid) and by dichloroacetic acid was observed. The dependence of the rate constant on concentration of hydrochloric acid is linear in the presence of, but not strictly linear in the absence of, added electrolyte in swamping concentration, which suggests the operation of a significant salt effect. For reactions in methanolic dichloroacetic acid–sodium dichloroacetate buffers, the results at high buffer concentrations point to a significant amount of association between acid and anion. This conclusion is compatible with molecular weight determinations by vapor-pressure osmometry. The kinetic results are analogous to those previously obtained for the acid-catalyzed hydrolysis of cyanoketen dimethyl acetal in aqueous solution. A common mechanism with a rate-limiting proton attachment to the olefinic double bond is indicated. Small amounts of residual water in the solvent do not greatly complicate the kinetic analysis. The hydrochloric acid-catalyzed reaction was also studied in mixtures of MeOH and MeOD. The theory of the solvent isotope effect appropriate to this type of solvent system and reaction is developed and applied, again pointing to a close similarity to the solvent isotope effect of the reaction in aqueous solution. It is shown that the study of the solvent isotope effect in alcoholic solutions offers a convenient alternative procedure to the use of buffers for the investigation of general acid catalysis. (auth)

8827 MECHANISM OF ELIMINATION REACTIONS. THE E2 REACTIONS OF SUBSTITUTED α-PHENYLETHYL BROMIDES. Yoshida, T.; Yano, Y.; Oae, S. (Osaka City Univ.). Tetrahedron; 27: No. 22, 5343-51(Nov 1971).

The rates of base-catalyzed elimination of a series of substituted α-phenylethyl bromides were determined in t-BuOK–t-BuOH, t-BuOK–t-BuOH–DMSO and EtONa–EtOH systems. The Hammett ρ values obtained were, although small and not in linear correlation with σ values, positive in all cases. β-Methyl group retarded the rate in t-BuOK–t-BuOH and in t-BuOK–t-BuOH–DMSO, but enhanced it in EtONa–EtOH. β-Hydrogen kinetic isotope effects were 5.0, 3.5, and 3.4, respectively. The nature of transition states is discussed in the light of these observations. (auth)

8828 ELIMINATION REACTIONS OF CYCLOOCTYLAMMONIUM SALTS IN LIQUID AMMONIA. Bach, Robert D.; Andrzejewski, Denis (Wayne State Univ., Detroit). J. Amer. Chem. Soc.; 93: No. 25, 7118-20(15 Dec 1971).

A study is reported of the reactions of trialkylcyclooctylammonium salts in liquid ammonia using potassium amide as the

base that proceed by a syn α', β mechanism. Results are tabulated for the percentage of cis-cyclooctene and trans-cyclooctene formed and for the syn k_H/k_D. (D.H.M.)

8829 ISOTOPE EFFECTS IN THE ARYLATION OF OLEFINS WITH PALLADIUM(II) ACETATE. THE MECHANISM OF OLEFIN ARYLATION. Shue, Robert S. (Phillips Petroleum Co., Bartlesville, Okla.). J. Amer. Chem. Soc.; 93: No. 25, 7116-17(15 Dec 1971).

The phenylation of styrene with benzene and benzene-d_6 exhibits a significant kinetic isotope effect of $K_H/K_D = 5.0 \pm 0.4$. The isotope effect found for the palladium(II) acetate effected coupling of benzene with styrene and styrene-d_6 was very small. It was suggested that cleavage of the styrene–β-hydrogen bond is not involved in the rate-determining step of olefin arylation. (D.H.M.)

8830 OXIDATIONS OF HYDROAROMATIC SYSTEMS. I. THE OXIDATION OF TROPILIDENE BY CERIC AMMONIUM NITRATE. Mueller, Paul; Katten, Elliott; Rocek, Jan (Univ. of Illinois, Chicago). J. Amer. Chem. Soc.; 93: No. 25, 7114-16 (15 Dec 1971).

A study was made to examine whether ceric ammonium nitrate (CAN) could react with a carbon–hydrogen bond in preference to a nonaromatic unsaturated system. Results show that CAN will not react even with a very reactive carbon–hydrogen bond in preference to a nonaromatic carbon–carbon double bond. The most important result of the study was a complete absence of any kinetic isotope effect in the oxidation of cycloheptatriene-d_8. (D.H.M.)

8831 C_2O, CN_2, AND C_3O MOLECULES. DeKock, R. L.; Weltner, W. Jr. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc.; 93: No. 25, 7106-7(15 Dec 1971).

An assignment was made of an infrared band that appears at 2244 cm^{-1} in the reaction of carbon atoms and molecules at temperatures near 4°K to the CCCO molecule that is formed by the trapping of carbon atoms with CO and their subsequent reaction to yield C_2O and then C_3O. All isotopic combinations of the available C and CO were allowed to react and the result for $^{13}C + {}^{12}C^{18}O$ is shown in the ir absorption spectra. (D.H.M.)

8832 MICROWAVE SPECTRUM, STRUCTURE, DIPOLE MOMENT, AND QUADRUPOLE COUPLING CONSTANTS OF AMINODIFLUOROPHOSPHINE. Brittain, A. H.; Smith, J. E.; Lee, P. L.; Cohn, K.; Schwendeman, R. H. (Michigan State Univ., East Lansing). J. Amer. Chem. Soc.; 93: No. 25, 6772-6(15 Dec 1971).

The microwave spectrum of PF_2NH_2 is consistent with a molecule containing a planar nitrogen configuration with the hydrogen atoms in the symmetry plane. The structural parameters are: $d(PF) = 1.587 \pm 0.004$ Å, $\angle FPF = 94.6 \pm 0.2°$; $d(PN) = 1.650 \pm 0.004$ Å, $\angle FPN = 100.6 \pm 0.2°$; $d(NH_{cis}) = 1.002 \pm 0.005$ Å, $\angle HNH = 117.2 \pm 0.4°$; $d(NH_{trans}) = 0.981 \pm 0.005$ Å $\angle PNH_{cis} = 123.1 \pm 0.2°$, $\angle PNH_{trans} = 119.7 \pm 0.4°$. Quadrupole coupling constants for the ^{14}N nucleus in $PF_2{}^{14}NH_2$ have the values $\chi_{aa} = 1.7 \pm 0.1$, $\chi_{bb} = -3.5 \pm 0.3$, and $\chi_{cc} = 1.8 \pm 0.3$ MHz. The dipole moment components for $PF_2{}^{14}NH_2$ were determined to be $\mu_a = 2.570 \pm 0.007$, $\mu_c = 0.18 \pm 0.01$ D and yield a total dipole moment of 2.58 ± 0.01 D which is inclined at an angle of 25.1° to the PN bond. The proton nmr spectrum of liquid $PF_2{}^{15}NH_2$ contains a single pair of transitions. The splitting, attributed to $^{15}N–H$ coupling, is 83.2 Hz, which is close to the value expected for a planar $-NH_2$ group. No further splitting is observed down to −70°, suggesting that on the nmr time scale the molecule is undergoing a rapid intramolecular conversion, probably an internal rotation about the P–N bond. (auth)

8833 MOLECULAR-BEAM MICROWAVE SPECTRA OF HNCO AND DNCO. Kukolich, S. G.; Nelson, A. C.; Yamanashi, B. S. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Chem. Soc.; 93: No. 25, 6769-71(15 Dec 1971).

Deuteron quadrupole coupling in DNCO was obtained from splittings of the 1_{01} rotational state. The measured quadrupole coupling strength for the 1_{01} rotational state is $eqQ(1_{01}) = 53.6 \pm 0.2$ kHz, which leads to a value along the D–N bond $eqQ_{DN} = 345 \pm 2$ kHz. Hyperfine splittings were observed using a molecular-beam maser spectrometer with 6-kHz resolution. The nitrogen quadrupole coupling strengths were $eqQ(1_{01}) = 2123.0 \pm 1.0$ kHz for DNCO and $eqQ(1_{01}) = 2052.7 \pm 0.1$ kHz for HNCO. High-precision values for the line-center frequencies and spin–rotation constants are also reported. (auth)

8834 GENERALIZED ORBITAL DESCRIPTION OF THE REACTIONS OF SMALL MOLECULES. Goddard III, William A.; Ladner, Robert C. (California Inst. of Tech., Pasadena). J. Amer. Chem. Soc.; 93: No. 25, 6750-6(15 Dec 1971).

The usual Hartree–Fock method leads to an improper description of the breaking of a bond, a problem that is overcome by the generalized valence-bond method. This method uses one orbital per electron as in the valence-bond method, but solves for the orbitals self-consistently as in the Hartree–Fock method. The changes in the orbitals as the H_2 and LiH bonds are broken and the orbital description of the $H_2 + D \rightleftharpoons H + HD$ and $LiH + H \rightleftharpoons Li + H_2$ exchange reactions are considered. The orbital description leads to simple concepts in terms of which the changes in the system during reaction can be understood. It is expected that these concepts will apply to a large number of reactions. (auth)

8835 MECHANISM AND KINETICS OF ISOTOPIC EXCHANGE IN ZEOLITES. I. THEORY. Brown, L. M.; Sherry, H. S.; Krambeck, F. J. (Mobil Research and Development Corp., Princeton, N. J.). J. Phys. Chem.; 75: No. 25, 3846-55(9 Dec 1971).

A new model is presented for particle-controlled isotopic exchange of both bound (sited) and randomly distributed (mobile) cations contained in hydrated zeolites with ions in electrolyte solutions. Isotopic exchange in such systems can take place in one or more observable steps, depending on the number of crystallographically distinct cation sites and the relative rates of migration of the different types of cations. The observed kinetics are explained in terms of a mechanism that consists of coupled diffusional and exchange processes. Sited cations migrate by means of an intracrystalline exchange with mobile cations followed by diffusion. However, the model predicts cases of diffusion-controlled kinetics for the overall process when exchange is at least as fast as diffusion. The model is described mathematically by a linear combination of Fick's second equation for diffusion and first-order kinetics for exchange. An analytic solution of the rate equations for a two-step process is derived and discussed in relation to isotopic exchange and ion exchange in zeolites A and X. (auth)

8836 CORRELATION OF ISOTOPE EFFECTS WITH MOLECULAR FORCES. II. TRIATOMIC MOLECULES. Bigeleisen, Jacob (Univ. of Rochester, N. Y.); Ishida, Takanobu; Spindel, William. J. Chem. Phys.; 55: No. 10, 5021-8(15 Nov 1971).

The theory of the relationship between the reduced partition function ratio of isotopic molecules and molecular force constants in triatomic molecules was developed through application of finite orthogonal polynomials. Detailed calculations are presented for ^{13}C and ^{18}O substitution in CO_2 at 500 and 1000°K, and ^{2}H and ^{18}O substitution in H_2O at 1000 and 2000°K. The quantum correction of order j is jth order in diagonal force constant elements, but essentially linear in off-diagonal force constant elements. Stretch-bend interaction force constants are typically of increasing importance to the higher quantum corrections. In some cases, such as ^{18}O substitution in water, the stretch-bend interaction constant is an order of magnitude more important than the stretching force constant to all quantum corrections other than the simple first quantum correction. The quantum corrections were analyzed into contributions corresponding to the statistical mechanics of a single oscillating particle and coupling terms with other atoms in the molecule. The first quantum correction is always a purely statistical mechanical term. For D substitution in water, the higher-order quantum corrections are principally statistical mechanical in origin, whereas, for ^{18}O substitution in water, these terms are predominantly coupling terms. (auth)

8837 PHOSPHORESCENCE OF BENZOPHENONE, BENZOPHENONE-d_{10}, AND DECAFLUOROBENZOPHENONE IN RIGID GLASSES AND CRYSTALS UNDER PRESSURE. Simpson, Jerry; Offen, Henry (Univ. of California, Santa Barbara). J. Chem. Phys.; 55: No. 10, 4832-6(15 Nov 1971).

The phosphorescence of benzophenone, benzophenone-d_{10}, and decafluorobenzophenone was studied as a function of pressure (0 to 30 kbar) at 77°K in nonpolar and polar glasses, as well as from molecules at pressure-induced defect sites in the corresponding crystals. The pressure shift in the triplet spectra was in the order $\Delta\nu_F > \Delta\nu_D \gtrsim \Delta\nu_H$, while lifetimes were shortened 15 to 25% at 30 kbar. The blue shift in hydroxylic glasses and the red shift observed both in hydrocarbon glasses and at crystal defects were rationalized in terms of hydrogen bonding, dielectric interactions, and repulsive interactions, respectively. (auth)

8838 HYDROGEN–DEUTERIUM EXCHANGE WITH ANTHRACENE–POTASSIUM AND ANTHRACENE–SODIUM COMPLEXES. Tsuchiya, Susumu; Ponec, Vladimir; Sachtler, Wolfgang M. H. (Rijksuniversiteit, Leiden). J. Catal.; 22: No. 2, 280-2(Aug 1971).

The reaction was followed using a mercury-free closed system

with a U-shaped glass tube reactor. The H–D mixture was analyzed by a mass spectrometer attached to the reaction system. It was found that in many reactive collisions both atoms of one hydrogen molecule were exchanged with two hydrogen atoms of the complex. Rate constants were measured and results supported the conclusion that the equilibration proceeds via a heterophase exchange mechanism. (M.C.G.)

8839 MICROWAVE SPECTRUM, MOLECULAR STRUCTURE, FORCE FIELD, AND DIPOLE MOMENT OF THIOCARBONYL SELENIDE, SCSe. Hirose, Chiaki; Curl, R. F. Jr. (Rice Univ., Houston, Tex.). J. Chem. Phys.; 55: No. 10, 5120-3(15 Nov 1971).

The microwave spectrum of SCSe was observed in the (0, $1^{\pm1}$, 0) and (0, $2^{\pm2}$, 0) vibrational states. The transitions observed were: J = 7 ← 6, 8 ← 7, and 9 ← 8 for ^{80}Se and ^{78}Se species, and J = 8 ← 7 and 9 ← 8 for ^{76}Se and ^{82}Se species. It was not possible to observe directly the transitions of the ground state, but ground state rotational constants extrapolated from the two vibrationally excited states are 2043.310, 2060.321, 2078.190, and 2027.113 MHz for $^{32}S^{12}C^{80}Se$, $^{32}S^{12}C^{78}Se$, $^{32}S^{12}C^{76}Se$, and $^{32}S^{12}C^{82}Se$, respectively. These values differ considerably from those reported previously. The vibration–rotation constant α_2 and the l-type doubling constant q_l are also obtained as α_2 = −4.133, −4.169, −4.215, and −4.116 Mhz, and q_l = 1.005, 1.021, 1.041, and 0.996 MHz for $^{32}S^{12}C^{80}Se$, $^{32}S^{12}C^{78}Se$, $^{32}S^{12}C^{76}Se$, and $^{32}S^{12}C^{82}Se$, respectively. The centrifugal distortion constant D_J was determined to be 0.163 and 0.22 kHz for ^{80}Se and ^{78}Se species. The molecular force field was calculated from q_l to be f_{C-Se} = 5.72, f_{C-S} = 7.97, $f_{rr'}$ = 0.59, and f_α/r_1r_2 = 0.20 mydn/Å. The dipole moment in the (0, $2^{\pm2}$, 0) state was measured to be 0.031 D. (auth)

8840 TEMPERATURE DEPENDENCE OF DEUTERIUM ISOTOPE EFFECT IN FLUORESCENCE OF AROMATIC HYDROCARBONS. Lim, E. C.; Bhattacharjee, H. R. (Wayne State Univ., Detroit). J. Chem. Phys.; 55: No. 10, 5126-7(15 Nov 1971).

The occurrence of a temperature-dependent isotope effect in the fluorescence of aromatic hydrocarbons, which is in qualitative agreement with the prediction based on the theoretical model of Fischer, is reported. Values for anthracene are discussed. (M.C.G.)

8841 DIFFUSIVITY OF ^{3}He, ^{4}He, H_2, D_2, Ne, CH_4, Ar, Kr, AND CF_4 IN $(C_4F_9)_3N$. Powell, R. J.; Hildebrand, J. H. (Univ. of California, Berkeley). J. Chem. Phys.; 55: No. 10, 4715-16(15 Nov 1971).

An earlier paper from this laboratory reported that diffusion coefficients of gases in CCl_4 multiplied by their molecular cross sections are the same for gases heavier than Ne, but that they increase linearly from D_2 to ^{4}He with the square of the de Boer quantum parameter Λ^*. The present study of gases in $(C_4F_9)_3N$ includes ^{3}He. For relative cross sections, instead of uncertain values of σ^2, the $^2/_3$ power of the critical volumes, V_c, accurately known from critical densities was used. Measured values conform to the equation $10^2DV_c^{2/3} = 70(1 + 1.94\Lambda^{*2})$. Diffusion coefficents in CCl_4, multiplied by $V_c^{2/3}$ yield $10^2DV_c^{2/3} = 70(1 + 3.00\Lambda^{*2})$. The relative steepness of the two quantum lines is 3.00 ÷ 1.94 = 1.60, exactly the same as the ratio of the internal pressures of the two liquids, 3350/2160. (auth)

8842 MECHANISM OF THE DESULFONYLATION OF PHENYL SULFONE IN MOLTEN SULFUR. Asperger, S.; Hegedic, D.; Pavlovic, D.; Stefanovic, D. (Univ., Zagreb. Inst. Rudjer Boskovic, Zagreb). J. Org. Chem.; 36: No. 24, 3845-6(3 Dec 1971).

The kinetics of the overall reaction between sulfur-35-labeled phenyl sulfone and molten sulfur in nitrogen atmosphere at 243, 262, 288, and 297° were studied, and the corresponding first-order rate constants, $k \times 10^6$ sec^{-1}, found to be 5.21 ± 0.12, 19.2 ± 0.3, 120 ± 1, and 209 ± 9, respectively (uncertainties are standard deviations of the mean). Using the technique of least squares, the energy of activation for the overall reaction was found to be 41 ± 1 kcal $mole^{-1}$, and the frequency factor 1.0×10^{12} sec^{-1}. The entropy of activation was found to be −7 eu. Assuming the C–S stretching frequency of 700 cm^{-1} the maximum isotope effect for decomposition of the hypothetical C–S molecule was calculated to be 1.07% ($^{32}k/^{34}k$ = 1.0107) at 243°. The sulfur-34 isotope effect for the overall reaction at 243° was determined with $^{32}k/^{34}k$ = 1.0043 ± 0.0012. Isotope effects for the two sub reactions involved in the overall process were estimated. It is concluded that appreciable C–S bond weakening takes place in the transition state, suggesting dissociation as a rate-determining step, followed by loss of sulfur dioxide and subsequent recombination of Ph· and S· radicals. (J.G.B.)

8843 INVESTIGATIONS INTO REACTION MECHANISMS OF PEROXYBENZOIC ACID TOWARD DIAZODIPHENYLMETHANES. Curci, Ruggero; Di Furia, Fulvio; Marcuzzi, Franco (Univ., Padua). J. Org. Chem.; 36: No. 24, 3774-8(3 Dec 1971).

The reaction of diazodiphenylmethane Ph_2CN_2 with peroxybenzoic acid $PhCO_3H$ in benzene, Et_2O, or i-PrOH produces benzophenone in high yields along with benzoic acid and nitrogen, whereas no detectable amount of benzhydryl peroxybenzoate $PhC(=O)OOCHPh_2$ is formed. Reaction stoichiometry is 1 mole of peroxybenzoic acid (PBA) to 1 mole of diazodiphenylmethane (DDM) and a second-order-overall (order one in each of the reagents) kinetic law is obeyed. Kinetic data concerning reaction of DDM with PBA in nine solvents of varying characteristics show a parallelism with data for PBA oxidation of p-nitrodiphenyl sulfide and of cyclohexene. Substituents effects were studied by measuring reaction rates for four substituted diazodiphenylmethanes [$XC_6H_4C(=N_2)C_6H_5$, with X = p-OCH_3, p-Cl, m-NO_2, p-NO_2] with PBA and for DDM with p-nitroperoxybenzoic acid. The effect of isotopic substitution (PBA-d_1) on rates was also determined. Reaction mechanisms which account for the results are discussed. (auth)

8844 DETERMINATION OF ACTIVE HYDROGEN BY EXCHANGE WITH DEUTERIUM OXIDE. EXTENSION TO POLYMERS AND OTHER DIFFICULTLY SOLUBLE MATERIALS. Olson, Paul B.; Ganon, John G.; Mendel, Arthur (Minnesota Mining and Mfg. Co., St. Paul). Anal. Chem.; 44: No. 1, 182-4 (Jan 1972).

The analysis of difficultly soluble substances by an extension of a previously reported procedure is described. Briefly, the material was dissolved in a high-boiling solvent, reacted with deuterium oxide at elevated temperatures, and D_2O layer separated. Where a deuterium oxide-miscible solvent was used, the D_2O layer was subsequently separated by azeotropic distillation. A conventional infrared spectrometric method was then applied. (J.G.B.)

8845 KINETIC HYDROGEN ISOTOPE EFFECTS IN THE CATALYTIC HYDROGENATION OF ALKENES. Siegel, Samuel; Ohrt, David W. (Univ. of Arkansas, Fayetteville). J. Chem. Soc., D; No. 23, 1529-30(8 Dec 1971).

Observed kinetic hydrogen isotope effects in catalytic hydrogenation reactions are functions of the apparent order of the reaction with respect to hydrogen; the range of values to be expected is governed by the equilibrium constant for the exchange reaction involving hydrogen and the deuterated catalyst. (auth)

8846 DEUTERIUM SOLVENT ISOTOPE EFFECTS IN METHANOL SOLUTION. PART IV. THE SOLVOLYSIS OF ACETIC ANHYDRIDE. Gold, V.; Grist, S. (London Univ.). J. Chem. Soc., B; No. 11, 2285-6(1971).

The solvent isotope effect on the methanolysis of acetic anhydride was measured for mixtures of MeOH and MeOD. Both the extreme rate ratio (k_H/k_D = 2.82) as well as the behavior in isotopically mixed solvents are very similar to corresponding effects in the hydrolysis and suggest that both the reaction mechanism and the theory of the solvent isotope effect in methanolysis are closely comparable with those applicable to the hydrolysis. (auth)

8847 DEUTERIUM SOLVENT ISOTOPE EFFECTS IN METHANOL SOLUTION. PART III. PROTON TRANSFER FROM 2-NITROPROPANE AND FROM 3-METHYL-1-PHENYLBUTYL PHENYL KETONE TO METHOXIDE ION. Gold, V.; Grist, S. (London Univ.). J. Chem. Soc., B; No. 11, 2282-5(1971).

The extreme solvent isotope effects for racemisation of D-(+)-3-methyl-1-phenylbutyl phenyl ketone (α-phenylisocaprophenone) (k_D/k_H = 2.04) and the ionization of 2-nitropropane (k_D/k_H = 2.28) were measured for methanolic solutions of sodium methoxide at 25°C (where k_D refers to MeOD as solvent). The existence of large solvent isotope effects in reactions of this type implies a solvation number of 3 for the methoxide ion, if larger values are ruled out on structural grounds. Measurements in mixtures of MeOH and MeOD are interpreted in terms of the appropiately modified theory of solvent isotope effects and are shown to be consistent with a multiply solvated methoxide ion. The primary (substrate) isotope effect for the ionization of 2-nitro [2-$^2H_1$] propane is found to have the value 7.4 in MeOH solution and ca. 6.9 in MeOD. (auth)

8848 ISOTOPIC EXCHANGE OF ETHYLENE AND DEUTEROETHYLENE, AND ISOMERIZATION OF BUTENES ON NICKEL CHLORIDE CATALYST. Maruya, Ken-ichi; Ando, Naoki; Ozaki, Atsumu (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi; 92: No. 8, 699-702(Aug 1971). (In Japanese).

It was reported in a previous paper that nickel chloride evacuated at 140 to 300°C is active for the dimerization of ethylene. The

nature of active sites on the nickel chloride was elucidated by means of isotopic mixing in ethylene and isomerization of butenes. Isotopic mixing in ethylene as well as the dimerization of ethylene was completely poisoned by 0.1 μmole/g of preadsorbed carbon monoxide, whereas the isomerization of butenes was unaffected by this amount of carbon monoxide. Maximum activities for these three reactions were commonly obtained when nickel chloride was evacuated at around 230°C. Both the dimerization and isotopic mixing were promoted by a nickel site on which carbon monoxide was preferentially chemisorbed, whereas the isomerization was promoted by an acid site formed during the evacuation by a reaction represented as $NiCl_2 + H_2O \rightarrow Ni(OH)Cl + HCl$. The acid site seems to contribute to the dimerization too. (auth)

8849 TITANIUM ISOTOPE FRACTIONATION IN THE SYSTEM CONSISTING OF GASEOUS HYDROGEN CHLORIDE AND SOLVATES OF PYRIDINE HYDROCHLORIDE WITH HYDROGEN CHLORIDE. Szydlowski, J.; Zielinski, M. (Univ., Warsaw). Radiochem. Radioanal. Lett.; 8: No. 5, 291-5 (18 Dec 1971).

The tritium exchange between gaseous hydrogen chloride and pyridine hydrochloride was studied. The isotope effect on the equilibrium of this reaction and its temperature dependence were estimated. (auth)

8850 CONFORMATIONAL ANALYSIS OF LYSOZYME BY HYDROGEN–DEUTERIUM EXCHANGE. McBride-Warren, Patricia Ann. Lawrence, Kan.; Kansas State Univ. (1971). 183p. University Microfilms Order No. 71-20,131.

Thesis.

A study was undertaken to more adequately ascertain the mechanism of hydrogen–deuterium exchange in a biological macromolecule. It was thought that this could be accomplished by developing a way to find reliable values of both rate constants and class sizes. The measurement of H–D exchange of lysozyme in the overtone region of the near infrared was found to be a most sensitive method to follow the reaction. This is accomplished by observing both NH decrease at 1.515 μ and HOD increase at 1.41 μ. Rate constants measured from HOD production equaled those obtained from NH decrease and therefore provided evidence that this technique measures peptide hydrogens only. Three rate constants were necessary to adequately describe the absorbance vs time data for both HOD production and NH disappearance within ±0.4 pD units of the minimum (3.95), while two constants sufficed beyond this region. A plot of each set of rate constants vs pD showed the characteristic parabola observed with specific acid and base catalysis. Indeed, the data for k_2 and k_3 could be satisfactorily described by the equation for specific acid and base catalysis, $k = k_0 + k_D(D^+) + k_{OD}(OD^-)$ with k_0 essentially equal to zero. While a plot of log k_2 vs pD gave a positive slope of 1.0 for the basic catalyzed portion of the exchange, a negative slope of 0.75 indicated repression of the acid catalytic constant with increasing deuterium ion concentration. Calculations of the number of hydrogens associated with each kinetic class remained essentially constant for the fast and intermediate classes over the entire pH interval investigated. Constant class size clearly shows that lysozyme maintains its structural integrity in acid solution. An average of 54 out of a possible total of 128 peptide hydrogens was found not to exchange after 24 hours. On the basis of total exchange measurements, 17 peptide hydrogens could not be accounted for and are assumed to lie on the polar surface of the molecule and exhibit instantaneous exchange by this method. Comparison of exchange constants obtained with lysozyme to those obtained from model compounds suggests that the environment for exchange in lysozyme may very possibly be more apolar than in random coil structures such as poly-DL-alanine. Since the numbers of hydrogens per class were found to be reproducible to within ±4 hydrogens, it will now be possible with this method to detect conformational changes involving as few as 5 to 10 peptide hydrogens. (Diss. Abstr. Int., B)

8851 LASER EXCITED FLUORESCENCE OF I_2, RAMAN SPECTRA OF PERIODATE CRYSTALS, AND RAMAN SPECTRA OF CRYSTALLINE ACETYLENE AND DEUTERATED ACETYLENE. Hatzenbuhler, Douglas Albert. East Lansing, Mich.; Michigan State Univ. (1970). 168p. University Microfilms Order No. 71-18,218.

Thesis.

The laser-excited (Ar^+ 5145 Å and HeNe 6328 Å) fluorescence spectra of iodine vapor were studied. A study was made of the Raman spectra of periodate crystals. The shifts in periodate fundamentals were found to be dominated by an electrostatic (site) interaction potential. Five of the six Raman active lattice modes were observed and symmetries assigned. The Raman spectra of crystalline C_2H_2 and C_2D_2 were obtained to aid in the determination of the crystal structure of the lower temperature phase. In general, the D_{2h} factor group with two molecules per primitive cell on C_{2h} (⊥) sites interprets all spectral features, except ν_4 of C_2D_2 which has two additional unpredicted components. Mixed crystal spectra were also obtained where one isotope was matrix isolated in a host lattice of the other isotope. The spectral splittings were interpreted in terms of site and factor group terms, and intensity calculations were performed using the "oriental gas" model. The intensity calculations support an angle of ≈45° between the molecular axis and the crystallographic z axis. (Diss. Abstr. Int., B)

8852 ISOTOPE EXCHANGE OF HYDROGEN IN ETHYL AND BENZYL DERIVATIVES OF $C_5H_5Mn(CO)_3$ AND $C_5H_5Mn(CO)_2CPPh_3$. Nefedova, M. N.; Setkina, V. N.; Khatami, A. I.; Ginzburg, A. G.; Kursanov, D. N. (Inst. of Elemental-Organic Compounds, Moscow). Dokl. Akad. Nauk SSSR; 198: No. 4, 889-91(1 Jun 1971). (In Russian).

This article is part of a continuing investigation of the effect of a substituent on the rate of electrophilic isotopic exchange of hydrogen in sandwich compounds. The influence of ethyl and benzyl groups on hydrogen exchange in cyclopentadiene rings by deuterium in acid media was studied in the systems $C_5H_5Mn(CO)_3$ and $C_5H_5Mn(CO)_2PPh_3$. The quantity of deuterium in the cyclopentadiene and phenyl rings was determined by measuring the intensity of the corresponding signals in PMR spectra at different degrees of exchange in $C_5H_5CH_2C_5H_4Mn(CO)_3$. Appreciable exchange was observed in the phenyl ring only after exchange equilibrium had been achieved in the cyclopentadiene ring. (K.S.W.)

8853 NEW METHOD FOR DETERMINATION OF ISOTOPE EXCHANGE REACTIONS BASED ON SUPERPOSITION OF KINETICS AND DIFFUSION; SIMULATION ON AN ANALOG COMPUTER. Heckner, Karl-Heinz; Ruhtenberg, Wolf-Dieter (Humboldt Univ., Berlin). Z. Chem.; 11: No. 7, 273-5(Jul 1971). (In German).

A new principle is described involving the superposition of diffusion and isotope exchange. The method is based on pulse diffusion and requires no analytical chemical separation of reactants. The principle of pulse diffusion is explained and underlying processes are formulated mathematically. Comparison between experimental values and computer data shows that pulse diffusion yields reliable rate constants for a range from 0.01 to 5.1 $mole^{-1}$ sec^{-1}. (H.B.G.)

8854 SELF-DIFFUSION AND THE ISOTOPE MASS EFFECT IN SINGLE CRYSTALLINE BENZENE. Fox, R.; Sherwood, J. N. (Univ. of Strathclyde, Glasgow). Trans. Faraday Soc.; 67: No. 587, 3364-71(Nov 1971).

A study was made of the isotope mass effect in self-diffusion in single crystals of benzene as a function of temperature in the range 240 to 274°K. The tracers were ^{14}C-labelled normal benzene and ^{3}H-labelled deuterobenzene. The self-diffusion coefficients are represented by $D = D_0 \exp - E/RT$ where $D_0 = 1.43 \times 10^5$ m^2 s^{-1} and $E = 96.7 \times 1.5$ kJ $mole^{-1}$ for the ^{14}C species and $D_0 = 1.53 \times 10^5$ m^2 s^{-1} and $E = 96.9 \times 2.5$ kJ $mole^{-1}$ for the ^{3}H species. A direct comparison of the rates of diffusion of the two labelled species yields a value for the mass factor $E_b^a = f\Delta K = 0.78 \pm 0.03$. Agreement between this factor and the probable value for the correlation factor for vacancy self-diffusion, $f = 0.78$, suggests that self-diffusion proceeds via a vacancy mechanism. (auth)

8855 ARRIVAL TIME DISTRIBUTIONS IN HIGH-PRESSURE MASS SPECTROMETRY. II. REACTIONS OF $(H,D)_3^+$ IN HYDROGEN–DEUTERIUM MIXTURES. Chang, C.; Sroka, G. J.; Meisels, G. G. (Univ. of Houston, Tex.). J. Chem. Phys.; 55: No. 11, 5154-7(1 Dec 19[illegible]).

Arrival time distributions of H_3^+ ions in hydrogen, D_3^+ ions in deuterium, and of these ions and their isotopically mixed analogs in equimolar mixtures of hydrogen and deuterium have been measured using a pulsed high-pressure ion source and individual ion flight time measurements. The ratio of the reduced mobilities of the hydronium ions in the pure gases was found to be 1.41, in good agreement with previous measurements and with the theoretical expectation of $\sqrt{2}$. Drift velocities are linear functions of E/P but do not go through the origin because mean residence times do not accurately correspond to the reciprocal drift velocities of the ion packets. In the mixtures, however, reduced mobilities of all isotopically substituted ions are identical even though a difference by as much as 13% is expected, approximately 3 times the standard deviation. This is interpreted in terms of a rapid H^+ or D^+ transfer, and a lower limit of 0.9×10^{-10} cc sec^{-1} is established for the rate constant of the hydrogen transfer reactions. (auth)

8856 DEPENDENCE OF THE RATES ON ION KINETIC ENERGY FOR THE REACTIONS $D_2^+ + D_2$ AND $HD^+ + HD$. Huntress, W. T. Jr. (California Inst. of Tech., Pasadena); Elleman, D. D.; Bowers, M. T. J. Chem. Phys.; 55: No. 11, 5413-14(1 Dec 1971).

Experiments similar to those of Clow and Futrell have been repeated. The results for $D_2^+ + D_2 \rightarrow D_3^+ + D$ show the relative rate increasing at first and then decreasing with kinetic energy. The results for $HD^+ + HD \rightarrow H_2D^+ + H$ and $\rightarrow HD_2^+ + D$ confirm the qualitative results of Bowers, Elleman, and King: the H_2D^+/HD_2^+ ratio increases with kinetic energy. (D.L.C.)

Physical Chemistry

Refer also to abstracts 9765–9767, 9860, 9933, 10336, and 10903.

8857 (ANL-Trans-901) FINE STRUCTURE OF ELECTRONIC SPECTRA OF HEPTAVALENT NEPTUNIUM. Chaikhorskii, A. A. Translated by Lydia Venters (Argonne National Lab., Ill.), from Radiokhimiya; 13: No. 2, 302-5(1971). 5p. Dep. NTIS.

The absorption spectra of aqueous solutions of Np(VII) have a rather noticeable fine structure. The Np(VII) does not have electrons in the outer shells; therefore, two bands at 4120 and 6200 Å, possessing relatively high values of the molar extinction coefficient, were assigned to the electron transfers $\pi \rightarrow 5f$. The remaining bands were assigned to the vibrational spectra. The spectra indicate the existence of Np(VII) in the form of NpO_2^{3+} with the point symmetry $D_{\infty h}$. (M.C.G.)

8858 (CEA-N-1487) DETERMINATION OF EQUATIONS OF STATE OF GASEOUS UF_6, MoF_6, WF_6, ClF_3 WITH THE DIELECTRIC METHOD. Morizot, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 23p. (In French). Dep. NTIS (U. S. Sales Only).

The technique for measuring dielectric constants was used to determine the molar polarization, nonideality, and dipole moment of UF_6, MoF_6, WF_6, and ClF_3. Comparisons are made between these nonideality parameters and those obtained by other methods. It is demonstrated that dielectric nonideality parameters of these gases are unsettled by an adsorption phenomenon on the electrodes. (auth) (France)

8859 (CONF-690426–, pp 116-33) FLUORIDE AND SULPHATE COMPLEXES OF HEXAVALENT NEPTUNIUM. Musikas, C.; Sontag, R. (Commissariat a l'Energie Atomique (France). Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

The results obtained both by potentiometry at imposed current and at nul current were found to be nearly the same in the media where Np(V) is stable. When NpO_2^+ undergoes disproportionation, the potentiometry at imposed current could be conveniently used. Four successive fluoride complexes of NpO_2^{+} were found as in the case of UO_2^{++}. In sulfuric acid medium, in addition to the two complexes reported before, the slope of the curve of potential versus log (HSO_4^-/H^+) suggests the formation of a third complex when sulfate concentration is higher than 0.6 M. Hexavalent neptunium fluoride complexes are less stable than the corresponding uranium complexes while the sulfate ones are slightly more stable. (auth)

8860 (CONF-690426–, pp 143-51) LANTHANIDE AND ACTINIDE STANDARD II-III OXIDATION POTENTIALS AND THE OPTICAL ABSORPTION SPECTRA OF SOME LANTHANIDE AND ACTINIDE TRIHALIDES IN ETHANOL. Nugent, L. J.; Baybarz, R. D.; Burnett, J. L. (Oak Ridge National Lab., Tenn.). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

Information consistent with recent chemical work on the II–III oxidation potentials of some of the lanthanide and transplutonium elements is presented that indicates that a linear Barnes and Day type lanthanide calibration plot shifted by +0.8 volts can be applied to the transplutonium series and substantiates Jorgensen's spin-pairing energy treatment of electron-transfer spectra and related oxidation potentials. (D.H.M.)

8861 (COO-294-20) STUDIES OF (1) ACTINIDE AND LANTHANIDE IONS AND (2) ORGANIC MOLECULES IN TRIPLET STATES BY MAGNETIC RESONANCE METHODS. Technical Progress Report, March 1, 1971–November 12, 1971. Hutchinson, Clyde A. Jr. (Chicago Univ., Ill. Dept. of Chemistry). 12 Nov 1971. Contract AT(11-1)-294. 9p. Dep. NTIS.

Research progress is reported on f electron systems in single crystals of actinides and lanthanides and organic molecules in triplet states. (D.H.M.)

8862 (COO-1149-194) LOW TEMPERATURE CHEMICAL THERMODYNAMICS PROJECT. Technical Progress Report No. 19, November 1, 1970–November 1, 1971. Westrum, Edgar F. Jr. (Michigan Univ., Ann Arbor). 1 Nov 1971. Contract AT(11-1)-1149. 28p. Dep. NTIS.

Thermophysical studies on uranium oxides are reported. Phase studies on praseodymium oxide and thermodynamic properties of the oxide are discussed. Research on thermal capacities of inorganic compounds and thermophysical properties of molecular crystals is mentioned. (M.C.G.)

8863 (KFK-1403) MAPLIB FUNCTIONS FOR CALCULATION OF THE ENTROPY OF He, AIR, CO_2, AND H_2O. Zimmerer, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). May 1971. 53p. (In German). Dep. NTIS (U. S. Sales Only).

The following materials were included in the material property library MAPLIB; air, helium, carbon dioxide, and water (liquid and steam). The naming conventions as specified in (KFK-1253) are followed for both the material names and the property names. All data are supplied in the MKSAK (meter, kilogram, second, ampére, kelvin) unit system. For all functions the physical and mathematical validity range was tested. (auth)

8864 (ORNL-4706, pp 119-82) PHYSICAL CHEMISTRY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

Research progress is reported on physical chemistry in the following areas: aqueous solutions, molten salts and related nonaqueous systems, calorimetry, and electrochemistry. (D.H.M.)

8865 (ORO-2907-83) STUDIES IN THE PHYSICAL CHEMISTRY OF SELECTED HIGH-TEMPERATURE SYSTEMS. Progress Report, December 1, 1970–November 30, 1971. Margrave, John L.; Brooks, Philip R. (Rice Univ., Houston, Tex. Dept. of Chemistry). 16p. Dep. NTIS.

8866 CRYSTAL STRUCTURE OF TRIINDENYLURANIUM CHLORIDE. Burns, John H.; Laubereau, P. G. (Oak Ridge National Lab., Tenn.). Inorg. Chem.; 10: No. 12, 2789-92(Dec 1971).

The crystal structure of triindenyluranium chloride, $U(C_9H_7)_3Cl$, was determined from single-crystal x-ray diffraction data by use of Patterson and Fourier techniques and refined by the method of least squares to an R index of 0.047. The orthorhombic unit cell has a = 8.576 Å, b = 14.24 Å, c = 16.73 Å; the space group is $P2_12_12_1$; and Z = 4. In each molecule of the structure a uranium atom is bonded almost symmetrically to the carbon atoms of the five-membered ring of each of three planar indenyl ring systems at distances of 2.67 to 2.89 Å and to one chloride ion at 2.593 Å, in a tetrahedral array. Some types of bonding that are consistent with the observed molecular structure are discussed. (auth)

8867 NEW THORIUM NITRATE HYDRATE. Moseley, P. T.; Sanderson, S. W.; Wheeler, V. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 33: No. 11, 3975-6(Nov 1971).

The existence of $Th(NO_3)_4 \cdot 5H_2O$ was confirmed and a new hydrate also reported in the $Th(NO_3)_4 - HNO_3 - H_2O$ system. When the "Analar" material was recrystallized from concentrated HNO_3 at room temperature well-defined crystals of $Th(NO_3)_4 \cdot 5H_2O$ were obtained, and when a 3.5M solution of this was left to stand at room temperature for 5 to 7 days the first product to crystallize consisted of colorless needles showing a monoclinic cell with a = 1.76 ± 0.01, b = 1.65 ± 0.01, c = 2.42 ± 0.01 nm, β = 88.5 ± 0.10. Analytical results were in reasonable agreement with the formula $H_2Th(NO_3)_6 \cdot 3H_2O$. It is pointed out, however, that in most of the experimental work mixtures of phases were present and the phase diagram is very complex. On heating in air to 55 to 60°C, or pumping at room temperature, the weight loss corresponded to $3H_2O$, regained on standing in air at room temperature. This is thought to be the first report of an acid nitrate of Th. It is possible, however, that the true formulation may be $Th(NO_3)_4 \cdot (5-x)H_2O \cdot xHNO_3$, in which part of the water is replaced by HNO_3. A structure determination is under way. (UK)

8868 STUDY OF THE HYDRATED OXIDE OF Pa(V). Vernois, J.; Muxart, R. (Institut du Radium, Arcueil, France). Rev. Chim. Miner.; 8: No. 4, 613-19(1971). (In French).

The aging of the hydrated pentoxide of Pa was studied using x-ray diffraction, and infrared spectroscopic techniques. The spectra of products prepared from deuterated solutions (D_2SO_4, D_2O, and ND_4OD) were obtained in order to confirm or reject the existence of Pa–OH groups in the hydrated pentoxide. The aging of the hydrated pentoxide of Pa due to prolonged contact with water at

100°C manifests itself by a reorganization of the first crystalline phase (fcc) of the anhydrous pentoxide that can be revealed using x-ray diffraction techniques. The aging in the dry state or in the liquor of the precipitation is accompanied by a reorganization of the crystal lattice, which is not detectable by x-ray crystallography. (France)

8869 HYDROLYSIS OF THORIUM NITRIDES AND CARBONITRIDES. Sugihara, Suano; Imoto, Shosuke (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 630-6(Nov 1971).

Studies were made on the hydrolysis by water and water vapor of thorium nitrides (ThN, Th_3N_4, and Th_2N_2O) and carbonitrides. All the thorium nitrides and carbonitrides were found to decompose in water below 100°C, changing thereby into ThO_2. The order among the thorium nitrides in their propensity toward hydrolysis is: $ThC_{1-x}N_x$ > ThN > Th_3N_4 > Th_2N_2O. Upon hydrolysis, ThN produced NH_3 and H_2, but in the case of the higher nitrides no H_2 was found to evolve. In the reaction between ThN and water vapor, no higher nitride was produced, in contrast to the case of UN. The difference in behavior between ThN and UN was studied from the standpoint of differences in crystallographic conditions for the transformation from mononitride into higher nitrides. Through the hydrolysis of $ThC_{1-x}N_x$ in water vapor, products containing C–C, C–C–C, and C–N bonds, such as ethane and amines, were found in smaller quantities than for the case of $UC_{1-x}N_x$. This fact as well as the difficulty of formation of higher nitrides has resulted in a fairly simple hydrolysis behavior of thorium nitrides. (auth)

8870 STRUCTURE AND THERMODYNAMICS OF LANTHANIDE AND ACTINIDE COMPLEXES IN SOLUTION. Choppin, Gregory R. (Florida State Univ., Tallahassee). Pure Appl. Chem.; 27: No. 1-2, 23-41(1971).

Several questions of importance in the study of lanthanide and actinide coordination compounds are reviewed. There is considerable evidence that in aqueous solution the primary coordination number is nine for the ions La(III) to Nd(III) and eight for the ions heavier than Gd(III). While it seems that some degree of covalency exists in the metal–ligand bonding, a model of electrostatic bonding seems satisfactory for explaining the structure and formation of the complexes. The dehydration of the lanthanide ions upon complexation largely determines the enthalpy and entropy data. However, there seems to be a compensation effect in the hydration parts of those terms such that the free energy changes seem to reflect the metal–ligand reaction unobscured by hydration factors. A number of individual inorganic and organic ligand systems are reviewed from these viewpoints. (50 references) (auth)

8871 MISCIBILITY GAPS IN FLUORIDE-CONTAINING FUSED SALTS. Grothe, K. H.; Franke, D. (Technische Univ., Hanover). Inorg. Nucl. Chem. Lett.; 7: No. 12, 1173-5(Dec 1971). (In German).

Apart from fluoride systems already cited in the literature, in connection with fuel reprocessing by solvent extraction with fused salts, the following compounds were found to form two liquid phases with AgCl for a molar ratio of 1 = 1: $TlBF_4$, K_2SiF_6, K_2TiF_6, K_2NbF_7, K_2ZrF_6, K_2TaF_7. The thermal stability of these complex fluorides and $NaBF_4$ under a nitrogen atmosphere was studied. The addition of 20 mole % KF reduces the weight loss on heating but KCl has no marked effect. The stability of the Si, Ti, and Zr salts increases with the atomic number of the central atom. Since the stability of the above complex fluorides seemed unsatisfactory those having a low vapor pressure and formed by mixing the individual fluorides were studied. Two liquid phases were formed with AgCl by 2 LiF · BeF_2, 2KF · ZnF_2, 2NaF · BeF_2, 2KF · BeF_2, 2KF · CdF_2, and 2KF · BiF_3. AgCl can be replaced by other substances which are also only slightly polar, e.g., $CdCl_2$, $SnCl_2$, and $PbCl_2$. Since Li, Na, and K fluoroberyllates lead to miscibility gaps with AgCl it may be assumed that these alkali metals can be interchanged in the other systems cited and still produce two liquid phases with AgCl. The latter could also be replaced by AgBr or AgI. (UK)

8872 ABSENCE OF AN EFFECT OF OXIDE ON THE SOLUBILITY AND THE ABSORPTION SPECTRA OF PuF_3 IN MOLTEN LiF–BeF_2–ThF_4 AND THE INSTABILITY OF PLUTONIUM(III) OXYFLUORIDES. Bamberger, C. E.; Ross, R. G.; Baes, C. F, Jr.; Young, J. P. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 10, 3591-4(Oct 1971).

In order to explore the possibility that PuOF and/or other plutonium oxyfluorides can exist at equilibrium with molten fluorides either as solids or in solution, the effect of oxide on the solubility and on the absorption spectra in molten fluorides was studied. The results obtained showed that the solubility of PuF_3 as a function of temperature in the presence and absence of ThO_2 was the same within the scatter of the analytical data. The spectrum of Pu(III) in molten LiF–BeF_2–ThF_4 obtained at 575°C is given and is the same in solutions derived from melts whether they contained O^{2-} ion or not. (UK)

8873 STUDY OF AMMONIUM PLUTONIUM(IV) FLUORIDES. II. THE THERMAL DECOMPOSITION OF AMMONIUM PLUTONIUM(IV) FLUORIDES, AMMONIUM CERIUM(IV) FLUORIDE, AND AMMONIUM URANIUM(IV) FLUORIDE. Yahata, Taneaki; Muromura, Tadasumi; Ouchi, Kinji; Naito, Keiji (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 33: No. 10, 3339-43(Oct 1971).

Thermal decomposition of PuF_4 · 7/6NH_4F (or PuF_4 · NH_4F), PuF_4 2NH_4F, CeF_4 · 7/6NH_4F (or CeF_4 · NH_4F) and UF_4 · 7/6 NH_4F (or UF_4 · NH_4F) were studied under vacuum and in inert gas flow, using a microthermobalance. The anhydrous PuF_3, CeF_3 and UF_4 were obtained as the decomposition products. The following reactions appeared to occur in thermal decomposition of these double salts: MF_4 · 7/6NH_4F = MF_3 + 5/6NH_4F + 8/6HF + 1/6N_2 (M = Pu and Ce) and UF_4 · 7/6NH_4F = UF_4 + 7/6NH_4F. (auth)

8874 CRYSTALLINE STRUCTURE OF URANIUM TETRANITRATES. Kapshukov, I. I.; Volkov, Yu. F.; Moskvichev, E. P.; Lebedev, I. A.; Yakovlev, G. N. (Scientific Research Inst. of Atomic Reactors, Melekess, USSR). Zh. Strukt. Khim.; 12: No. 1, 94-8(Jan-Feb 1971). (In Russian).

Complex compounds of uranium of the type $M_2[UO_2(NO_3)_4]$ were investigated by x-ray analysis; here M represents NH_4, Rb, or Cs. All three compounds were isomorphic and belong to the monoclinic system. The structure consists of the cation M^+ and the complex anion $[UO_2(NO_3)_4]^{2-}$. In the centro-symmetric complex anion two nitrate groups are associated with the U atom, and two groups form an equatorial plane of sixfold coordinated oxygen atoms around the U atom. The U–O bonds in the uranyl group are shortened and are equal to 1.78, 1.77, and 1.85, respectively, for M = NH_4, Rb, and Cs. (tr-auth)

8875 CRYSTAL STRUCTURE OF URANIUM DIPHOSPHIDE UP_2. Pietraszko, D.; Lukaszewicz, K. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 4, 237-42(1971).

The crystal structure of UP_2 was determined from three-dimensional data collected on a single-crystal diffractometer with Mo K_α radiation. The crystals of UP_2 are tetragonal, space group I 4 mm with a = 5.386 Å, c = 15.563 Å, c/a = 2.889; Z = 8. The structure was refined by the least squares method with the final R = 10.95% for 168 independent reflections. (auth)

8876 RADIOACTIVE KRYPTONATES OF ION EXCHANGERS. I. LOW VACUUM ADSORPTION OF ^{85}Kr ON ION EXCHANGERS. Toelgyessy, J.; Lesny, J. (Slovak Technical Univ., Bratislava). Radiochem. Radioanal. Lett.; 8: No. 5, 311-14(18 Dec 1971).

The technique of low vacuum ^{85}Kr adsorption on some types of ion exchangers is described and results of the first experiments reported. (auth)

8877 THERMODYNAMIC STABILITY OF CRYSTALLINE DEUTERIUM. Semenchenko, V. K.; Badra, Kh. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 3, 379-80(Mar 1971).

Translated from Zh. Fiz. Khim.; 45: No. 3, 685-6(Mar 1971).

The thermodynamic stability of crystalline deuterium is considered as a function of the percentage content of para-D_2. This made it possible to determine the type of phase transition in D_2 and the region corresponding to its occurrence. (auth)

Radiation and Nuclear Chemistry

Refer also to abstract 10902.

8878 (BMBW-FBK-71-12) ANNUAL REPORT, 1970. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Oct 1971. 131p. (In German). Dep. NTIS (U. S. Sales Only).

Operation of the Mainz TRIGA reactor is discussed. Methods are described for: chemical isolation of tin, technetium, ruthenium, the platinum metals, the rare earth elements, and the elements 104 and 105; volatilization of fission products from UF_4; preparation of carrier-free ^{202}Tl; and identification of short-lived neutron-rich isotopes of the elements arsenic, bromine, krypton, iodine, and xenon. Nuclear spectroscopy was used to study decay of the nuclides ^{100}Nb, ^{134}Sb, ^{106}Tc, ^{107}Tc, ^{152}Pm, and ^{192}Re–Os. X–γ coincidence measurements were made of fission

products from ^{235}U; Moessbauer spectroscopy of ^{57}Fe in metals is reported. Charge distributions in the chain 132 from $^{235}U(n_{th},f)$ and in chains 133, 134, and 135 from $^{232}Th(n_3,f)$ and $^{232}Th(n_{14},f)$ were determined. Systematics of cross sections of (n,p) and (n,α) reactions and the reaction cross section of $^{17}O(n_{14},p)^{17}N$ were found. Isomer ratios of ^{178}Lu were investigated. Search for superheavy elements in nature is reported. Activation analysis studies on gunshot residues and on turquoises and assay of arsenic in technical products are described. Detection of ^{7}Be in fallout is reported. (M.C.G.)

8879 (ORNL-4706, pp 100-12) RADIATION CHEMISTRY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

Research progress in radiation chemistry is reported in the following areas: ozone formation in the pulse radiolysis and flash photolysis of oxygen; absorption spectrum and reaction kinetics of the HO_2 radical in the gas phase; radiation chemistry of gaseous methane; photooxidation and fluorescence of cerium(III) in aqueous sulfuric acid solutions; reduction of cerium(IV) by hydrogen peroxide; dependence of reaction rate on Hammett's acidity function; reduction of cerium(IV) by nitrous acid in aqueous nitric acid solution; energy transfer and the radiolysis of aliphatic carboxylic acids; and radiation and hot-atom chemistry of inorganic crystalline solids (a Raman spectral study of the ^{60}Co γ radiolysis of ^{18}O-enriched polycrystalline KNO_3.) (D.H.M.)

8880 PROGRESS OF RADIATION USE IN CHEMICAL INDUSTRY. Machi, Sueo (Japan Atomic Energy Research Inst., Takasaki). Seikiyu To Sekiyu Kagaku; 15: No. 3, 90-4(Mar 1971). (In Japanese).

Radiation use in the chemical industry is reviewed. Characteristics of radiation processing are explained. Several problems in industrialization of radiation processing are pointed out and the present status of industrial use and development research of radiation processing is surveyed. Modification of plastics by crosslinking, production of composite materials (wood–plastics, concrete–plastics, and metal–plastics), modification of plastics by graft polymerization, curing of coating material, polymerization, organic synthesis, and use of radiation in water pollution problems are described. (Japan)

8881 FORMATION OF ORGANIC IODIDES ON DISSOLUTION OF IRRADIATED URANIUM METAL IN NITRIC ACID. Tachikawa, E.; Tamura, N.; Furukawa, K.; Motojima, K. (Japan Atomic Energy Research Inst., Tokai). Int. J. Appl. Radiat. Isotop.; 22: No. 11, 793-8(Dec 1971).

Radio-gas chromatography was used for separation and identification of volatile iodine compounds released in the dissolution of irradiated U metal in HNO_3 solutions, in order to obtain information concerning the formation mechanisms of organic iodides. The dependence of ^{131}I distribution ($CH_3\,^{131}I$, $C_2H_5\,^{131}I$) on irradiation time of the U metal, the effects of dissolving temperature, the effects of the addition of iodine compounds into concentrated HNO_3 and the effects of dilution of HNO_3 with water, on ^{131}I distribution, are each tabulated. The possible formation mechanism of the organic iodides is discussed. It is stated that the results reported may be useful for aqueous fuel reprocessing. (UK)

8882 RATE CONSTANTS AND CROSS SECTIONS FOR THE PRODUCTION OF OH^- FROM O^- AND H^- IN WATER. Melton, Charles E.; Neece, George A. (Univ. of Georgia, Athens). Contract AT(40-1)-3729. J. Amer. Chem. Soc.; 93: No. 25, 6757-9 (15 Dec 1971).

Rate constants and cross sections for the reactions $H^- + H_2O \rightarrow OH^- + H_2$ and $O^- + H_2O \rightarrow OH^- + OH$ were measured as a function of energy in the energy range from 0 to 10 eV. The results show a $V^{-\frac{1}{2}}$ energy dependence for the cross section in the energy range from 0 to 5 eV for both reactions. At higher energies the cross section is about constant with increasing energy. The change in the function is interpreted as a contribution to the abundance of OH^- from the reactions $H^- + H_2O \rightarrow OH^- + 2H$ and $O^- + H_2O \rightarrow OH^- + O + H$. The experimental value for the rate constant for the reaction of H^- with H_2O was found to be $k = 3.8 \times 10^{-9}$ cm^3 molecule^{-1} sec^{-1} compared to a theoretical value of $k = 3.1 \times 10^{-9}$ cm^3 molecule^{-1} sec^{-1}. These values are about an order of magnitude lower than those previously reported for this reaction in the literature. The value of the rate constant for the reaction of O^- with H_2O was $k = 1.35 \times 10^{-9}$ compared to the theoretical value of $k = 1.0 \times 10^{-9}$ cm^3 molecule^{-1} sec^{-1}. No previous value of this rate constant is available for comparison with the present results. Results from this study show that the theory of ion–molecule reactions can be used to estimate rate constants for reactions of anions and neutral molecules. (auth)

8883 SOME APPLICATIONS OF THE OPTICAL APPROXIMATION TO RADIATION CHEMISTRY. Chen, Chia Ting. Houston, Tex.; Univ. of Houston (1970). 155p. University Microfilms Order No. 71-19,099.

Thesis.

On the basis of the optical approximation, an attempt was made to calculate the average energy of excited species ($\bar{E}_x$) and the average energy of ionic species ($\bar{E}_i$) including the average energy of secondary electrons ($\bar{E}_s$) for the gases under study. Various methods of calculation of $\bar{E}_i$ are discussed. The values of $\bar{E}_x$ are also calculated from the energy balance equation. The energy deposition function of ethane was calculated from the photoelectron spectrum and compared with that from the photoionization data. The energy distributions of secondary and subexcitation electrons were derived within the theoretical frame work of the optical approximation. Thus, the average energy of secondary electrons and that of subexcitation electrons ($\bar{E}_{se}$) can be calculated from the energy spectra. The $\bar{E}_s$ was compared with the difference of the ($\bar{E}_i + \bar{E}_s$) from the optical approximation and the $\bar{E}_i$ from other methods. The $\bar{E}_{se}$ was compared with the results calculated from the ElKomoss-Magee formula. The energy balance equation was applied to calculate the relative yields of excited and ionic species, N_x/N_i, for the gases under investigation. The calculated results, in most cases, are in fair agreement with the experimental results provided that the energetic secondary electrons are taken into consideration. The disagreements in some gases are discussed. The yields of excited states in argon are evaluated. An interpretation of the apparent failure in the previous application of the optical approximation in the calculation of yields of excited states in argon is offered. (Diss. Abstr. Int., B)

8884 RADIATION-INDUCED CHAIN REACTIONS. Bansal, Krishan M. (Carnegie-Mellon Univ., Pittsburgh); Freeman, Gordon R. Radiat. Res. Rev.; 3: No. 2-3, 209-77(Oct 1971).

The radiation-sensitized chain reactions in liquid and gas phases are discussed. Polymerization is excluded from consideration. Chain initiation, rate equations, pulse radiolysis, aqueous systems, oxidation of alcohols by electron scavengers, isomerization, addition to olefins, atom exchange, oxidation of chloroform, oxidation of unsaturated hydrocarbons, dimerization of 1,3-cyclohexadiene, radiation-sensitized pyrolysis, and ionic mechanisms are considered. Gas-phase rate parameters were compiled. (206 references). (M.C.G.)

Radiation Effects

Refer also to abstracts 8783, 10274, and 10290.

8885 ELECTRON REACTIONS WITH THYMIDINE IN γ-IRRADIATED FROZEN AQUEOUS GLASSES. Lenherr, A. D.; Ormerod, M. G. (Royal Military Coll. of Science, Shrivenham, Eng.). Proc. Roy. Soc. (London), Ser. A; 325; No. 1560, 81-99 (5 Oct 1971).

Frozen glass-like matrices suitable for optical absorption measurements were produced by carefully freezing solutions of 6 mole/l sodium hydroxide, 9 mole/l enthanediol and 6 mole/l sulphuric acid. Electron spin resonance spectroscopy was used to examine the formation and reactions of radicals in these glasses with and without additives. With thymidine present study was made on the mechanisms of 5- thymyl radical formation and the nature of the preceding primary species. Cystamine was used as an electron scavenger for both comparison and competition purposes. Using the combined techniques of ESR and optical absorption spectroscopies, quantitative measurement of radical yields were made and the optical extinction coefficients of some of the reactive intermediates measured. These species were electrons and thymidine, cystamine and SO_4^- anions, and 5-thymyl and cystamine radicals. The results show in all three matrices that electron reactions with thymidine produce anions which protonate to give 5-thymyl radicals during thermal or ultraviolet bleaching. In the acid glass hydrogen addition reactions could account for up to 12% of the 5-thymyl radicals produced. The structures of the thymidine anion and 5-thymyl radical under the different pH conditions used are discussed in relation to the ESR hyperfine splittings, and using thymine the effect of the sugar group was also examined. Comparisons of these results with those from pulse radiolysis at room temperature show good agreement and support the interpretations. (auth)

8886 DELAYED DECOMPOSITION OF HEXAHYDRO-1,3,5-TRINITRO-s-TRIAZINE (HEXOGEN) AFTER IRRADIATION. Cherville, Jean; Linares, Bernard; Darnez, Charles; Le Bleis, Elaine. Int. J. Radiat. Phys. Chem.; 3: No. 4, 457-65(Dec 1971). (In French).

The decomposition of hexogen irradiated in the solid state by ^{60}Co γ-radiation was studied by ir spectroscopy, mass spectroscopy, chromatography, radiochromatography, and electron spin resonance. This work shows that about a half of the radiolytical products are in the solid state. The radiation chemical yield G measured by a new method is between 3.5 and 4.5 for doses of 3 to 5 megarads. The most important phenomenon consists in a delayed decomposition which goes on for several days. This decomposition is attributed to the effect of nitrogen peroxide trapped during irradiation in the hexogen. (auth)

8887 HIGH ENERGY RADIATION TREATMENT OF TALL OIL. Case, Forrest N. (to United States Atomic Energy Commission). U. S. Patent 3,597,344. 3 Aug 1971. Filed 10 May 1968.

Highly energetic radiation was found effective to reduce the Gardner color index of fatty acids derived from tall oil as well as other vegetable or animal sources. Additionally, the rate of crystallization of rosin acids is considerably inhibited by highly energized radiation. (auth)

8888 NITROXIDES IN THE OXIDATION OF BICYCLIC OXIMES. AN ELECTRON PARAMAGNETIC RESONANCE STUDY. Caragheorgheopol, A.; Caldararu, H.; Constantinescu, T.; Sahini, V. Em (Inst. of Physical Chemistry, Bucharest). J. Amer. Chem. Soc.; 93: No. 25, 6766-9(15 Dec 1971).

The nitroxide radicals RR'NO that appear in the oxidation of bicyclic oximes with lead tetraacetate were investigated by means of EPR spectroscopy. Three types of radicals were found to have the following characteristics: type i, $a_N \sim 13$ G, $g \sim 2.0061$; type ii, $a_N = 11.7$ G, $a_H = 9.6$ G, $g = 2.0061$; type iii, $a_N \sim 8$ G, $g \sim 2.0069$. It was also shown that polycrystalline samples of oxime, when γ-irradiated, yield selectively iminoxy radicals. It was observed that in a few days these decay and nitroxide radicals gradually appear. Nitroxide radicals also were observed in solution when the irradiated samples are dissolved. (D.H.M.)

8889 OBSERVATIONS OF TRIPLET-STATE RADICALS IN IRRADIATED SINGLE CRYSTALS OF CARBAZIDE. Reiss, Keith; Gordy, Walter (Duke Univ., Durham, N. C.). J. Chem. Phys.; 55: No. 11, 5329-33(1 Dec 1971).

The ESR of carbazide ($NH_2NHCONHNH_2$) after γ irradiation at 77°K exhibits signals corresponding to an effective g value of 4 in addition to the components centered at $g = 2$. These half-field lines correspond to second-order $\Delta M_S = \pm 2$ transitions of a spin triplet state which result from isotropic exchange couplings of electronic spin centers located on two NH fragments, probably on the $\dot{N}H-NH-CO-NH-\dot{N}H$ biradical but possibly on $NH_2-NH-CO-NH-\dot{N}H-\dot{N}H_2-NH-CO-NH-\dot{N}H$ radical pairs. An analysis of the anisotropic dipolar coupling tensor yields the principal values $D_{||} = 665.0$ G and $D_{\perp} = -332.5$ G. There are two distinguishable biradical orientations for which separate spectra occur. Except for this difference in orientation, the biradicals are identical. The mean value, $R = 4.37 \pm 0.04$ Å, is found for the separation of the exchange coupled electron spins. In addition to the biradicals, the related radical $NH_2NHCONHNH$ and other unidentified radicals having only one unpaired electron are observed. These latter species greatly exceed the number of biradicals formed. Analysis of the temperature dependence of the biradical half-life by isothermal annealing gave the activation energy for the decay to be $E_\alpha = 0.165$ eV. The radicals having single unpaired electrons were also observed to be thermally unstable, though not so much so as the biradicals. (auth)

8890 IMPROVING LOAD BEARING PROPERTIES OF REINFORCED PE BY GAMMA RADIATION. Raff, R. A. V.; Schecter, D. J.; Subramanian, R. V. (Washington State Univ., Pullman). Mod. Plast.; 48: No. 9, 74-6(Sep 1971).

Blends of high- and low-density polyethylenes with a number of reinforcing fillers, mainly glass fiber, aluminum oxide, and carbon black, after being subjected to gamma irradiation, have shown considerable improvement of properties. Both radioinduced grafting of polyethylene to the inorganic fillers, and crosslinking of polyethylene contribute substantially to the improvements. (auth)

8891 PRODUCTION OF CYCLIC MOLECULES DURING THE γ-IRRADIATION OF LINEAR POLYDIMETHYLSILOXANE. Tanny, G. B.; St. Pierre, L. E. (McGill Univ., Montreal). J. Polym. Sci., Part B; 9: No. 11, 863-8(Nov 1971).

The chromatogram of the volatile products of poly(dimethylsiloxane) irradiation yields three peaks, octamethylcyclotetrasiloxane, decamethylcyclopentasiloxane, and dodecamethylcyclohexasiloxane. The yields from both the thermal depolymerization and γ irradiation were plotted against the number of monomers of a ring of given size. The product distribution is similar, but the distribution shifted toward a larger ring size in the case of γ irradiation. (D.H.M.)

Radiation Processes

Refer also to abstracts 9384, 9687, and 9924–9926.

8892 (ORO-3687-1) RESEARCH AND DEVELOPMENT STUDIES INTO THE BASIC TECHNOLOGY OF RADIATION INDUCED EMULSION POLYMERIZATION INCLUDING SMALL SCALE PILOT PLANT SYSTEMS. Final Report. Stannett, V. T.; Stahel, E. P.; Barriac, J.; Oda, E.; Omi, S.; O'Neill, T.; Russo, S.; Havawala, N. B.; Prehoda, G. S. (North Carolina State Univ., Raleigh. Dept. of Chemical Engineering). 1 Sep 1971. Contract AT(40-1)-3687. 150p. Dep. NTIS.

The radioinduced emulsion polymerization of butadiene, styrene-acrylonitrile, and butadiene–acrylonitrile comonomer systems was studied. In addition vinyl chloride was investigated both in emulsion and in bulk under precipitating conditions. Butadiene was found to polymerize extremely slowly in bulk and in emulsion. The styrene comonomer system was faster but also slow. However, extremely pure butadiene polymerized much faster and future efforts should be directed towards the use of exceptionally pure materials. Butadiene–acrylonitrile and acrylonitrile itself polymerized much more rapidly but exhibited a complex kinetic behavior. It was found difficult to produce true emulsion polymers with acrylonitrile itself although the emulsifier did change the course of the polymerization process and increase the rate considerably. G (monomer) values of more than 75,000 were readily obtained with pure acrylonitrile in "emulsion" systems. In the bulk polymerization of vinyl chloride the polymer precipitates initially as a fine powder that later coalesces to an opaque mass. G (monomer) values of about 10,000 were obtained; little post effect and a square root dependency of the rate on the dose rate were found. The emulsion polymerization proceeded smoothly with G (monomer) values of more than 100,000. The kinetics were found to be complex and not to fit any standard or known scheme. The molecular weights in both systems were essentially dependent only on the temperature, i.e., were governed by chain transfer to monomer. A recirculating flow reactor system was used to study the radioinduced emulsion polymerization of styrene. The pilot plant is equipped with automatic temperature measurement and control. The system is modular in design to facilitate changes in configuration. Mathematical analysis of the engineering flow system is carried out utilizing the model styrene system for which Smith–Ewart kinetic behavior is assumed. Major departure from standard batch kinetic behavior was found in the flow reactor scheme employed. The mixing of fluid elements of different reaction time histories gives rise to a major second effect believed to be the rapid transfer of emulsifier. Operating conditions of the flow system minimizing this effect are shown to yield results consistent with the theory of Smith–Ewart. Effects of the system engineering variables of temperature, agitation, emulsion composition, system volume ratios, and flow rate are presented. Rates as high as 15% per minute are reported for a standard styrene emulsion. The pilot plant demonstrates the engineering feasibility of flow reaction systems utilizing radiation initiation to carry out emulsion polymerization. (auth)

8893 LIGHT- AND γ-RAY-INDUCED REACTIONS OF PURINES AND PURINE NUCLEOSIDES WITH ALCOHOLS. Steinmaus, H.; Rosenthal, I.; Elad, D. (Weizmann Inst. of Science, Rehovot, Israel). J. Org. Chem.; 36: No. 23, 3594-8(19 Nov 1971).

Photochemical- and γ-induced reactions of purines and purine nucleosides with alcohols are described. The reactions of 6-substituted and 2,6-disubstituted purines resulted in substitution of an alcohol moiety for the hydrogen atom at C-8, while with 2-aminopurine a primary attack took place at the C-6 position of the purine system. Yields of up to 80% were obtained. A free-radical mechanism is proposed for the reactions, and the following order of reactivity of the various sites in the purine system toward the alcohol-free radicals was found: C-6 > C-8 > C-2. (auth)

8894 γ-RADIATION INDUCED ISOTOPE EXCHANGE IN THE CARBON MONOXIDE–CARBON DIOXIDE SYSTEM. STUDIES IN SILICA VESSELS. Domíney, D. A.; Wickham, A. J. (Berkeley Nuclear Labs., Eng.). Trans. Faraday Soc.; 67: No. 585, 2598-2606(Sep 1971).

The behavior of the isotopes ^{13}C, ^{14}C, and ^{18}O in the $CO-CO_2$ system in silica vessels was studied, and the usefulness of the system as a radiation dosimeter investigated. Each isotope was employed under identical conditions. For the exchange of an oxy-

gen atom between CO and CO_2 the established G-value of 4.2 was confirmed. Apparent anomalies between results involving carbon- and oxygen-isotope labelling were explained by a schematic initial reaction scheme involving participation of the silica: $C^{18}O^{18} \rightsquigarrow C^{18}O + (^{18}O)$, $(^{18}O) + C^{16}O \rightarrow C^{16}O^{18}O$, $C^{18}O^{18}O + Si^{16}O^{16}O \rightarrow (C^{18}O + {}^{18}O)_{ads.}Si^{16}O^{16}O \rightsquigarrow (C^{18}O + {}^{16}O)_{ads.}Si^{16}O^{18}O$, $(C^{18}O + {}^{16}O)_{ads.}Si^{16}O^{18}O \rightarrow Si^{16}O^{18}O + C^{18}O + (^{16}O)$, $(^{16}O) + C^{18}O \rightarrow C^{16}O^{18}O$, and $(^{16}O) + C^{18}O \rightarrow C^{16}O^{18}O$. (auth)

8895 PROBLEMS IN UTILIZATION OF SMALL ELECTRON ACCELERATORS. Sakamoto, Isamu; Mizusawa, Ken-ichi (Nissin-High Voltage Co. Ltd., Tokyo). Genshiryoku Kogyo: 17: No. 1, 45-9(Jan 1970). (In Japanese).

The present state of utilization of electron accelerators in chemical reactions is reviewed. Radiation modification of high-molecular-weight compounds, radiation graft polymerization, radiation polymerization and advantages and disadvantages of radiation curing of paint coating, and synthesis by radiation are discussed. For electron accelerators, the following are described, with emphasis on the radiation curing of paint coating, acceleration voltage, electron beam current, scanning width, absorbed dose and dose rate, radiation shielding for bremsstrahlung with lead or concrete, generation of ozone in electron accelerator operation, irradiation in inert gas atmosphere, conveyor, and measurement of the absorbed dose. (Japan)

8896 PROCEDURE FOR OBTAINING RESINOUS WOOD. Laizier, Jacques; Laroche, Roger; Marchand, Joseph (to Commissariat a l'Energie Atomique). French Patent 2,055,861. 14 May 1971. Filed 1 Aug 1969. (In French).

A procedure for obtaining resinous wood is described. An impregnant is used, which consists of either an expanding monomer of a wood cellulosic material, or a mixture of the expanding monomer and another monomer or prepolymer. The impregnated wood is then irradiated. (France)

8897 DEVELOPMENT OF ELECTRON BEAM CURING TECHNOLOGY. Ishiwatari, J. (Kansai Paint Co. Ltd., Hiratsuka, Japan). Genshiryoku Kogyo: 17: No. 3, 43-8(Mar 1971). (In Japanese).

Electron beam curing is discussed. By this treatment, paints are hardened at room temperature within a short time without any catalyst. No air pollution occurs because all of the coating solidifies. The area required for application of this method is much less than that usually required for curing by heating. The running cost is very low. The initial investment is high, application to curved materials is hard to practice, shielding from x rays is necessary, ozone is formed during practice, and this method is applicable only to those paints with radical polymerization-type binders. Sensitivity to radiation of various polymers and makers of electron accelerators are tabulated. (Japan)

8898 IMPROVEMENTS IN OR RELATING TO SYNTHESIS OF DODECYL MERCAPTAN. Hills, Peter Robert; Spindler Michael William; Carley-Macauly, Kenneth Wallace (to United Kingdom Atomic Energy Authority). British Patent 1,246,087. 15 Sep 1971. Filed 29 Sep 1967.

A radiation process for the synthesis of this compound is described. The main reaction involved is $C_{12}H_{24} + H_2S \rightarrow C_{12}H_{25}SH$ and a slide reaction is $2C_{12}H_{24} + H_2S \rightarrow (C_{12}H_{23})_2S$. An equimolar mixture of dodecene and H_2S is passed through the reactor vessel under irradiation at 0 to 50°C and about 20 atm; under which conditions the side reaction occurs to the extent of 3 to 4%. A flow diagram is presented, based on 75% product yield. Cobalt-60 would normally be used for irradiation purposes. (UK)

8899 METHOD FOR GRAFTING VINYL MONOMERS ONTO POLYMERS. Blin, Marie-Francoise; Candan, Raymond; Gaussens, Gilbert; Lemaire, Francis; Paoli, Dominique (to Commissariat a l'Energie Atomique). French Patent 2,045,261. 15 Feb 1971. Filed 30 Jun 1969. (In French).

This method concerns the grafting of polymerizable vinyl monomers onto a polymer. The polymer is exposed to γ radiation in an atmosphere consisting of the vapors of the vinyl monomers to be grafted, and an expanding agent of the polymer, in the presence of a polymerization inhibitor. The polymer may be a polyester, in particular, polyethylene phthalate or a cellulosic polymer, such as cotton. The vinyl monomer is chosen either from the group consisting of acrylic acid, methacrylic acid or their esters, or from the vinyl pyridine group. (France)

8900 PROCESS FOR GRAFTING ONTO A POLYOLEFIN POWDER AND THE RESULTING PRODUCTS. Petit, J. C.; Claude, B. (to Compagnie Francaise de Raffinage). French Patent 2,056,057. 19 Apr 1971. Filed 26 Aug 1969. (In French).

A process for grafting α-acrylic acid onto a polyolefin is described: the polyolefin powder, which has previously been exposed to ionizing radiation is brought into contact with an acrylic acid, in an air-free environment; this acid is either in the vapor state, if necessary diluted with an inert gas, or in an atomized state, if necessary diluted with an inert gas. (France)

8901 IMPROVED PROCEDURE FOR IMPREGNATING POROUS OBJECTS AND SUBSEQUENTLY EFFECTING POLYMERIZATION AND RETICULATION USING RADIATIONS. Pierlas, Rene; Guibert, Michel (to Conservatome Industrie). French Patent 2,055,989. 19 Apr 1971. Filed 14 Aug 1969. (In French).

A procedure for improving the physical properties of objects made of wood, plaster, or other porous materials, is described. The procedure consists of impregnating the object with a polymerizable liquid, or mixture of liquids, and effecting the polymerization in an atmosphere free from air, or oxygen. A characteristic of the procedure is that after impregnation, but before exposure to radiation, the porous object is coated with a protective liquid, which produces oxidizable products when irradiated. This liquid layer is solidified before the irradiation. (France)

8902 PROCEDURE FOR PREPARING COPOLYMERS OF OLEFINS AND VINYL MONOMERS. Duchemin, Jeanne; Teyssie, Philippe; Hayashi, Kanae; (and others) (to Commissariat a l'Energie Atomique). French Patent 1,603,773. 24 May 1971. Filed 22 Nov 1968. (In French).

A procedure for preparing copolymers of olefins and vinyl monomers is presented. A mixture of olefins and vinyl monomers is subjected to ionizing radiation in the presence of one or several metallic salts. The monomers are dissolved in a polar solvent. The intensity of the radiation varies between 10^2 and 10^5 rads/hr. The irradiation dose varies between 10^3 and 10^5 rads. (France)

8903 IRRADIATION-GRAFTED POLYMERIC FILMS. III. DEVELOPMENT OF IMPROVED ANION-SELECTIVE MEMBRANES FOR DESALTING WATER. Martin, E. C.; Dietert, R. D.; Hamil, H. F. (Southwest Research Inst., San Antonio, Tex.). Separ. Sci.; 6: No. 5, 637-44(Oct 1971).

Experimental anion-selective membranes were prepared and evaluated as electrodialysis membranes. The membranes were prepared by radiation grafting tertiary amines onto polyethylene films. After grafting, the membranes were made ionic in character by conversion to the corresponding hydrochloride or by quaternizing with 1-bromobutane. Evaluation demonstrated the feasibility of preparing membranes having acceptable transport numbers, dialysis coefficients, and electrical resistances for use in electrodialysis processes. (auth)

8904 CROSSLINKING POLYMERS. D'Alelio, Gaetano Francis (to PPG Industries, Inc.). British Patent 1,253,572. 17 Nov 1971. Filed 13 Jun 1969.

A process for preparing crosslinked insoluble polymers is described that comprises irradiating suitable polymers with 0.5 to 10 MR of high-energy ionizing radiation. It relates specifically to polymers having activated vinyl or vinylidine pendent groups extending from the linear polymer chain and particularly to polymers having acrylic or methacrylic radicals extending to branches from a linear polymer molecule. Such processes have hitherto proved expensive and have not been used industrially to any extent, being unable in most cases to compete economically with free radical initiator processes. The process claimed is stated to be economical and more suitable in other ways. High-energy electron is the preferred type of radiation. Many examples of the process are given. (UK)

8905 RADIATION-INDUCED REACTION OF ETHYLENE–CYCLOHEXANE–CARBON TETRACHLORIDE SYSTEM. Yamabe, Masamori; Shimizu, Harumichi (Tokyo Metropolitan Isotope Research Center). J. Polym. Sci., Part A-1; 9: No. 10, 2901-14 (Oct 1971).

The γ-induced reaction of ethylene with carbon tetrachloride in cyclohexane was carried under a pressure of 30 kg/cm² and at a temperature of 20°C. The liquid and the solid products were obtained. Their structures were discussed on the basis of infrared absorption spectra and differential thermal analysis curves. The liquid product is considered to be ethylene–carbon tetrachloride telomer. The solid product consists of three components, differing slightly in molecular structure and molecular weight. To clarify the reaction process, some runs with the ethylene–cyclohexane–(ethylene–carbon tetrachloride telomer) system were also carried out. In this system, only solid product was obtained. Thus, it is concluded that the reaction proceeds stepwise, the first step being the telomerization reaction and the second the graft polymerization of ethylene onto the telomer produced in the first step. (auth)

8906 TEMPERATURE EFFECTS IN γ-INITIATED POLYMERIZATION OF STYRENE. II. Sood, S. P. (Univ. of Hawaii, Hilo); Hodgins, J. W. J. Polym. Sci., Part A-1; 9: No. 11, 3383-3403(Nov 1971).

Experimental data are presented for the γ-initiated polymerization of commercial styrene at a series of temperatures above ambient. Examination of the early stages of polymerization (up to 10% conversion) has led to the following conclusions. For this system, there exists a critical temperature (109°C) above which the rate of polymerization is independent of dose rate, over a wide range of γ intensities. This dose rate independence is ascribed to a "limiting rate of initiation," characteristic of the intensity range. A consequence of this is that at a given temperature above the critical temperature the degree of polymerization is also dose rate-independent. The above phenomena can be expected in any vinyl monomer where the monomer is fairly active and produces relatively stable radicals. Experimental procedure is described, and kinetic analysis presented to substantiate the conclusions. (auth)

8907 CHEMISTRY OF ORGANIC FLUORINE COMPOUNDS. X. RADICALLY INDUCED REDUCTION OF C–Cl BONDS IN FLUOROCHLORO DERIVATIVES BY 2-PROPANOL. Liska, F. (Inst. of Chemical Tech., Prague); Dedek, V.; Holik, M. Collect. Czech. Chem. Commun.; 36: No. 8, 2846-56(Aug 1971).

Under the influence of uv or ^{60}Co γ radiation or in the presence of di-tert-butyl peroxide C—Cl bonds in —CClF— groups of fluorochloroalkanols of the $R^1R^2C(OH)(CF_2—CClF)_2—H$ and $R^1R^2C(OH)(CF_2—CClF)_3—H$ type, and in fluorochloroalkanones as for example $CH_3CO(CF_2—CClF)_2—H$, are selectively reduced in 2-propanol, while the C—Cl bonds in primary –CHClF groups remain intact. 1,1,1-Trifluoro-2,2,2-trichloroethane and 1,1,1-trifluoro-2,2-dichloroethane undergo reduction under these conditions. The course of the reduction and the application of NMR- and ir spectra for the identification of the products are discussed. (auth)

8908 INITIATION MECHANISM OF RADIATION-INDUCED IONIC POLYMERIZATION OF ISOBUTENE STUDIED BY CYCLOTRON RESONANCE. Irie, Masahiro (Hokkaido Univ., Sapporo); Aoyagi, Katsuyuki; Hayashi, Koichiro; Sohma, Junkichi; Miyamae, Teruo. Bull. Chem. Soc. Jap.; 44: No. 8, 2261-3(Aug 1971).

Results obtained by the ion cyclotron resonance (ICR) study on isobutene are presented and the initiation mechanism of the radioinduced-polymerization in the gas phase is clarified. (D.H.M.)

8909 CHEMISTRY AND MORPHOLOGY OF THE N-METHYLOLACRYLAMIDE CROSSLINK IN COTTON FABRIC. Broughton, Royall Melvin Jr. Raleigh, N. C.; North Carolina State Univ. (1970). 85p. University Microfilms Order No. 71-19,933.

Thesis.

A study was made of the chemistry and morphology of a durable-press finishing process for cellulosic textiles. N-methylolacrylamide is added to cellulose and heated to cause reaction (presumably etherification). This step is followed by an in situ reaction induced by ionizing radiation. Measurements of dry, and water-swollen dimensions of treated cellophane showed that crosslinking had occurred during irradiation and (to a lesser extent) during heat curing. The possibility of heat-induced, free-radical polymerization was demonstrated. Kinetics of the acrylic group reaction during irradiation was investigated. A modified, first order rate expression provided satisfactory agreement with the data. A lattice model was applied to the distribution of the acrylic groups in cellulose and was found to be inconsistent with the kinetic measurements. Two assumptions concerning the system morphology were proposed as a qualitative explanation for the inaccuracy of the model. A histochemical staining technique was developed, and electron microscopy was used to show that the morphological assumptions were reasonable. (Diss. Abstr. Int., B)

Radiolysis

Refer also to abstracts 9058, 9388, 10280, 10312, 10313, 10334, 10666, and 11326.

8910 (AE–414) RADIOLYSIS OF AQUEOUS TOLUENE SOLUTIONS. Christensen, H. C.; Gustafson, R. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr 1971. 20p. Dep. NTIS (U. S. Sales Only).

Aqueous toluene solutions were irradiated with ^{60}Co γ rays. In unbuffered solutions the various cresol isomers are formed in a total yield of 0.45, 0.87, and 0.94 molecules/100 eV absorbed energy in argon-, N_2O- and air-saturated solutions, respectively. The yields are reduced in acid (pH 3) solutions (G = 0.14, 0.14, and 0.52, respectively), but the reduction is compensated by the formation of 1,2-diphenylethane in yields of 0.49 and 1.60 in argon- and N_2O-saturated solutions, respectively. Benzyl radicals are formed through an acid-catalyzed water-elimination reaction from the initially formed hydroxymethylcyclohexadienyl radical. Phenyltolylmethanes, dimethylbiphenyls, and partly reduced dimers are also formed during the radiolysis. Xylene isomers and benzene are formed in trace quantities. The most remarkable effects of the addition of Fe(III) ions to deaerated acid toluene solutions are the formation of benzyl alcohol and benzaldehyde and an increase in the yield of 1,2-diphenylethane. (auth)

8911 (NP–19136) RADIOLYSIS OF BROMOBENZENE. Diss. Nr. 4490. Bossy, Jean-Marie (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1970. 125p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

The radiolysis of bromobenzene at room temperature was investigated using three radiation sources of varying dose intensity. The absorption spectra of the radiation-chemical-induced transients as well as the kinetics of their decay processes were investigated by means of kinetic spectroscopy. Product analysis indicated the presence of bromine atoms, phenyl radicals, and, at low radiation doses, excited states of bromobenzene. End-products were hydrobromic acid, bromine, the isomers of dibromobenzene, bromobiphenyl, and biphenyl. (M.C.G.)

8912 (RRL–3238-364) RADIATION CHEMISTRY OF AQUEOUS MICELLAR SYSTEMS. Fendler, J. H.; Bogan, G.; Fendler, E. J.; Infante, G.; Bansal, K. M.; Patterson, L. K. (Texas Agricultural and Mechanical Univ., College Station. Dept. of Chemistry. Carnegie-Mellon Univ., Pittsburgh, Pa.). 3 Dec 1971. Contract AT(30-1)-3238. 12p. (ORO–4179-10). Dep. NTIS.

The reactivity of radiolytically generated radicals toward charged and uncharged micelle-forming surfactants was found to be $e^-_{aq} < Cl_2^{-}\cdot < H\cdot < OH\cdot$. Rate constants for reactions of $Cl_2^{-}\cdot$ and OH· with surfactants are significantly smaller above the critical micelle concentrations than below them. The rate of electron addition to benzene is retarded by anionic and nonionic micelles but it is enhanced by cationic micelles. The base destruction yields, G(-bases), for irradiated aqueous pyrimidines in the presence of chloride ion are substantially influenced by micelle-forming surfactants. The use of micellar systems as possible models for enzymatic interactions and for molecular radiation biology is discussed critically. (auth)

8913 RADIATION CHEMISTRY OF METHYL IODIDE IN THE GAS PHASE. Donovan, J. Marie; Hanrahan, Robert J. (Univ. of Florida, Gainesville). Int. J. Radiat. Phys. Chem.; 3: No. 4, 491-501(Dec 1971).

The ^{60}Co γ radiolysis of pure methyl iodide vapor at 300 torr (40 kN m^{-2}) and 25°C was studied. Major products found and their respective G-values are: I_2, 0.16; HI, 0.13; H_2, 0.55; CH_2I_2, 1.4; CH_4, 2.9; C_2H_2, 0.12; C_2H_4, 0.065. Addition of I_2 as a radical scavenger reduced the initial G value for methane production to 1.4. The mechanism for production of CH_2I_2 and molecular CH_4 was assumed to involve hot methyl radicals. Iodine scavenging did not alter $G(H_2)$, $G(CH_2I_2)$, $G(C_2H_2)$ or $G(C_2H_4)$, indicating that molecular processes may account for as much as 70% of all observed product formation. Ethane was found to be a minor product; the initial 100 eV yield of about 0.07 was reduced to 0.0055 by scavengers added initially or produced in the radiolysis. Use of Hi as a radical scavenger resulted in a low initial $G(C_2H_2)$, which increased with dose to its value in pure CH_3I. The C_2H_4 yield was nearly twice that observed in the pure system. The rate of methane production showed an initial maximum of about 25 molecules/100 eV, and the G-value decreased to about 2.6 with a dose of 1×10^{20} eV. A chain mechanism is proposed to account for high CH_4 yields in the presence of excess HI, and some of the $G(CH_4)$ observed in pure CH_3I. (auth)

8914 PULSE RADIOLYSIS STUDIES OF SOLUTIONS OF TETRANITROMETHANE IN ISO-PROPANOL. Asmus, K.-D.; Chaudhri, Shamim A.; Nazhat, N. B.; Schmidt, W. F. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Trans. Faraday Soc.; 67: No. 585, 2607-17(Sep 1971).

Tetranitromethane (TNM) reacts by a dissociative electron capture process with solvated electrons in isopropanol ($k_{TNM} + e^-_s = 2.45 \times 10^{10}$ M^{-1} s^{-1}) to produce nitroform anions, $C(NO_2)_3^-$, and NO_2. Isopropanol radicals and isopropanolperoxy radicals also reduce TNM via an electron transfer reaction with bimolecular rate constants of 7×10^9 M^{-1} s^{-1} and 9×10^8 M^{-1} s^{-1},

respectively. In neutral and acid ($HClO_4$) solutions $C(NO_2)_3^-$ ions are neutralized to $C(NO_2)_3H$ by reaction with solvated protons ($k = 3.2 \times 10^8\ M^{-1}\ s^{-1}$) and by a proton transfer reaction from isopropanol molecules ($k = 4.5 \times 10^2\ M^{-1}\ s^{-1}$). $C(NO_2)_3H$ dissociates with $k = 3.2 \times 10^3\ s^{-1}$. The equilibrium constant of $C(NO_2)_3H \rightleftharpoons C(NO_2)_3^- + H^+_{iso}$ in isopropanol was determined to be $K = 1.0 \times 10^{-5}$ M. The yield of scavengable reducing species in irradiated isopropanol increases from G = 3.5 at 6.3×10^{-6} M TNM to G = 6.4 at 3.2×10^{-2} M TNM in argon saturated solutions, and from G = 0.75 to G = 4.2 for the same concentrations of TNM in O_2 saturated solutions. G(free solvated electrons) was measured to be 1.2. The formation and disappearance of ions were observed directly by means of pulse radiolysis conductivity measurements. The specific equivalent conductance of $C(NO_2)_3^-$ ions and solvated protons was determined to be $\Lambda_{C(NO_2)_3^- + H^+_{iso}} = 51\ \Omega^{-1}\ cm^2\ equiv.^{-1}$. (auth)

8915 STRUCTURE OF RADICALS PRODUCED BY γ-RADIOLYSIS. PART I. 3-METHYLPENTYL, 2-METHYLPENTYL, AND ISOPENTYL RADICALS. Kanick, Stephen W.; Linder, Ron E.; Ling, A. Campbell (West Virgina Univ., Morgantown). J. Chem. Soc., A; No. 19, 2971-2(1971).

Unequivocal evidence is presented that γ-radiolysis of 2-methylpentane, 3-methylpentane, and isopentane under matrix isolation conditions leads only to tertiary hydrogen atom loss. (auth)

8916 MECHANISM OF CYCLOHEXANE RING SCISSION IN RADIOLYSIS. Grachova, T. A. (Petrochemical Synthesis Inst., Moscow); Makarov, V. I.; Polak, L. S.; Avdonina, E. N. Radiat. Eff.; 10: No. 3, 157-67(Aug 1971).

The processes of cyclohexane radiolysis in the liquid and solid state were studied. The formation of unsaturated and saturated products of cyclohexane C–C bond scission were studied as a function of dose, dose rate, temperature, the amount of scavenger (O_2, NH_3, CO_2, N_2O, C_6H_6) and the concentration of cyclohexane–benzene mixtures. It was found that the yields of all the products of cyclohexane ring scission display a pronounced phase effect at the change of aggregate state from liquid to solid. It was shown that the formation of saturated and unsaturated products proceeds by entirely different mechanisms. It was concluded that in the condensed phase the major mechanism of low molecular weight unsaturated product formation involves the decomposition of superexcited electronic states of cyclohexane molecules with further decomposition and/or stabilization of fragments. Radiation chemical yields of processes resulting in product formation and involving both charged and neutral species were calculated. The comparison of radiation chemical data with the data of analysis of labelled products, formed by recoil tritium atoms in cyclohexene, leads to the conclusion that the mechanism of saturated product formation in radiolysis involves as a primary stage the scission of cyclohexane molecule C–C bonds by hot H atoms, produced in the system under irradiation. (auth)

8917 NEW METHOD FOR THE STUDY OF REACTIONS OF H ATOMS IN AQUEOUS SOLUTIONS. Kongshaug, M.; Steen, H. B. (Norsk Hydro Inst. for Cancer Research, Oslo). Nature (London) Phys. Sci.; 234: No. 45, 37-8(8 Nov 1971).

H atoms may be generated for the study of reactions of atomic hydrogen with solutes in water by a microwave discharge of molecular H_2, and a technique is described in which only the surface of the solution was exposed to H_2 and H atoms from the gas discharge; using this technique reaction mechanisms and rate constants could be determined simply from first order homogeneous reaction kinetics. In order to eliminate possible effects of uv and vacuum uv light emitted by the discharge, a T-shaped discharge tube fitted to a double reaction vessel was used, and it was verified that the molecular H_2 did not affect the sample. The dose rates were $(0.5\ to\ 2) \times 10^{-4}$ M/min and exposure times 0.5 to 4 min. Yields were linear with dose, and it was found that H atoms were the only reactive species introduced into the solutions. Solutions of $K_3Fe(CN)_6$ and p-bromophenol were exposed to the gas from the discharge and the yields of reduced ferricyanide and bromide ions were measured. Yields increased with solute concentrations to reach the same plateau values for concentrations $>10^{-3}$ and 3×10^{-2} M, respectively, indicating that H atoms react with both solutes to give equivalent amounts of the products. The increase of yields with concentration is attributed to competition between first order escape of H atoms from the solution and their pseudo-first order reaction with the solute. Recombination of H atoms did not occur. It is thought that the method may be a valuable tool not only for the quantitative study of H atom reactions in general, but also for the elucidation of radioinduced processes in water and aqueous solutions. (UK)

8918 ELECTRON SPIN RESONANCE DETECTION OF NITRIC OXIDE AND PENTACYANONITROSYLFERRATE(III) IN γ-IRRADIATED ANHYDROUS SODIUM NITROPRUSSIDE. Bloom, M. B. D.; Raynor, J. B.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 20, 3209-12(1971).

Exposure of anhydrous sodium nitroprusside to ^{60}Co γ-rays at 77°K resulted in ESR spectra of two species. One had $g_{||} = 2.0142$ and $g_{\perp} = 2.0716$ at 77°K, with no resolved coupling to ^{14}N. By comparison with data for other d^5 pentacyanonitrosyls, it is concluded that this species is the pentacyanonitrosylferrate(III). The other species had g and ^{14}N hyperfine tensors characteristic of liberating nitric oxide. (auth)

8919 γ-RADIOLYSIS OF GASEOUS $H_2S + SF_6$ MIXTURES. Huyton, D. W.; Woodward, T. W. (Univ. of Salford, Eng.). Trans. Faraday Soc.; 67: No. 586, 2989-96(Oct 1971).

Measurement of G(ion) ($= 100/W_M$) and $G(H_2)_M$ in $H_2S + SF_6$ mixtures, where W_M is the average energy required to produce an ion pair in the mixture, and G(ion) and $G(H_2)_M$ are the total ion yield and hydrogen yield respectively, enables energy partition parameters a to be calculated. These were found to be a = 1.64 for mixtures of stopping power fraction $Z = P_1/(P_1 + S_2P_2/S_1)$, (where P and S refer to pressure and stopping power of gases 1 and 2) between ≃ 0.2 and 1.0. Below Z ≃ 0.2 each mixture has its own particular a value and these values, in the main, decrease smoothly with decreasing Z to a ≃ 0.70 at Z = 0.02. The hydrogen produced in the mixtures from energy deposited in H_2S alone, $G(H_2)_{H_2S}$, is independent of SF_6 concentration when energy partition is calculated using these a parameters. Sulphur yields in the mixture $G(S)_M$ are much greater than $G(H_2)_M$; the imbalance is accountable by HF production. At low SF_6 concentration (high Z), $G(S)_M$ increases rapidly with SF_6 concentration from 7.0 in pure H_2S to 11.0 at Z = 0.98 (½ mol % SF_6). (auth)

8920 PULSE RADIOLYSIS STUDIES OF THE RADIOSENSITIZER NOR-PSEUDOPELLETIERINE-N-OXYL (NPPN). II. REACTIONS INVOLVING BIOLOGICAL RADICALS. Roberts, P. B.; Fielden, E. M. (Inst. of Cancer Research, Sutton, Eng.). Int. J. Radiat. Biol.; 20: No. 4, 363-71(1971).

Earlier work showed Norpseudopelletierine-N-oxyl (NPPN) to be an efficient N-oxyl radiosensitizer in anoxic bacterial systems. Comparison of the reaction rates of NPPN and other N-oxyls (TAN and TMPN) with radicals derived from thymine, thymidylic acid, native and denatured DNA was made. Apart from native DNA, the rates confirmed that the sterically unhindered NPPN molecule reacted between two and four times more rapidly with the bioradicals than TAN and TMPN. It was found that, whereas NPPN reacted in an apparently straightforward and predictable manner with native DNA radicals, the behavior of TAN and TMPN was more complex. The relevance of these findings to the efficiency of radiosensitization by NPPN is discussed. In the light of these results the molecular processes implicit in current theories of the mechanism of N-oxyl sensitization appeared inadequate. (auth)

8921 PULSE RADIOLYSIS STUDIES OF THE RADIOSENSITIZER NOR-PSEUDOPELLETIERINE-N-OXYL (NPPN). I. RADIATION CHEMISTRY. Fielden, E. M.; Roberts, P. B. (Inst. of Cancer Research, Sutton, Eng.). Int. J. Radiat. Biol.; 20: No. 4, 355-62(1971).

The rate of the reactions between the stable free radical radiosensitizer Norpseudopelletierine-N-oxyl (NPPN), and the primary and some secondary radioinduced radicals were measured in aqueous solution. Rapid reactions were observed in all cases with a typical rate constant of $5 \times 10^9\ M^{-1}\ sec^{-1}$ for the reaction of NPPN with OH radicals. Triacetoneamine-N-oxyl (TAN) was also found to react rapidly with OH, in disagreement with another published estimate. The yield of destruction of the nitroxyl group absorption at 242 nm was also measured in several systems. Each of the primary radicals modified the nitroxyl chromophore, but the OH radical was also found to attack other sites on the molecule, probably via hydrogen abstraction from the methylene groups. The possible use and advantages of NPPN as a general radical scavenger in free radical studies is discussed. (auth)

8922 RADIOLYSIS OF ETHERS. I. THE FORMATION OF HYDROGEN AND METHANE IN 1,4-DIOXAN, 2-METHYLTETRAHYDROFURAN, DI-ISOPROPYL ETHER AND DI-n-BUTYL ETHER. Kiss, F. (Inst. of Pure Chemicals, Brno); Teply, J. Int. J. Radiat. Phys. Chem.; 3: No. 41, 503-11(Dec 1971).

The hydrogen formed in the radiolysis of 1,4-dioxan, 2-methyltetrahydrofuran, di-isopropyl ether, and di-n-butyl ether was found to have electrons, hydrogen atoms, excited molecules and unscavengeable hydrogen as precursors. Their yields were determined using different scavengers. There are two kinds of cations radiolytically produced: one reacts with diethylamine giving ammonium cation while the other one does not. The total yield of scavengeable electrons was determined in 1,4-dioxan and

2-methyltetrahydrofuran using sulphuric acid as a scavenger. Significant yields of methane were found in di-isopropyl ether and in 2-methyltetrahydrofuran. A substantial part of methane is scavengeable. All yields are tabulated. (auth)

8923 ELECTROCHEMICAL DETECTION OF EXCITED STATES DURING PULSE RADIOLYSIS OF CRYSTALLINE ICE. Sharanin, J. I. (Inst. of Electrochemistry, Moscow). Nature (London) Phys. Sci.; 234: No. 44, 14-15(1 Nov 1971).

An effect is described that was observed during an investigation of the electric and optical properties of short-lived particles arising from irradiation of crystalline ice. A typical plot is shown of current signal and e^-_{hydr} against time. The two signals coincide initially, but subsequently the optical density due to e^-_{hydr} monotonically tends to zero, whereas the electric conductivity unexpectedly increases and then diminishes to its steady-state value. Since the increase in current occurs after e^-_{hydr} has disappeared it is reasonable to attribute the observed change in conductivity to an increase in OH^- and H^+ concentrations due to dissociation of excited water molecules. Reactions are proposed to account for the shape of the current curve. Experiments in which the dose per pulse was varied from 150 to 3,000 showed that the characteristic time of the conductivity decay is independent of dose. With decreasing temperature the magnitude of the increase in conductivity decreased, possibly due to an increase in the number of crystal defects during cooling. Apparently the presence of defects or impurity centers decreases the probability of excitation decay according to the reaction $H_2O^* \xrightarrow{k_1} H^+ + OH^-$, and with an increasing number of defects other processes of energy dissipation become dominant. (UK)

8924 FORMATION OF NH_2 RADICAL IN A γ-IRRADIATED FROZEN AQUEOUS AZIDE SYSTEM. Moorthy, P. N.; Rao, K. N.; Shankar, J. (Bhaba Atomic Research Center, Bombay). Nature (London) Phys. Sci.; 234: No. 44, 17-81(1 Nov 1971).

Observation of the NH_2 radical in a γ-irradiated frozen aqueous azide matrix is reported, and it is thought that this is the first instance that this radical has been observed in a matrix not containing ammonia or an amino-group. The ESR spectrum of γ-irradiated 0.5M NaN_3 at −196°C is shown and discussed. Superimposed on the doublet of the OH radical is a complicated pattern that must be ascribed to radicals arising from the solute. On warming to −115°C the remaining spectrum was basically a triplet and was identical with that of γ-irradiated 6M NH_3 at −196°C, the spectrum of which was previously identified as due to the NH_2 radical. Examination of the high field line of the NH_2 radical triplet shows that this radical is also present in the irradiated sample even at −196°C. More detailed work is in progress to elucidate the radiation chemistry of the system in the frozen state. (UK)

8925 FORMATION MECHANISM AND REACTION OF BENZENE CATION IN GAMMA-IRRADIATED BENZENE–SILICA GEL SYSTEMS. Nagai, Shiro; Ohnishi, S.; Nitta, I. (Japan Atomic Energy Research Inst., Neyagawa). Shokubai; 13: No. 1, 48-51(Mar 1971). (In Japanese).

ESR spectra observed in γ-irradiated benzene−silica gel systems were studied. At −196°C, a signal based on defects in the silica gel was predominantly observed. But when the temperature of the sample was slightly elevated, formation of the benzene cation was observed. From this change in the ESR spectra, it was concluded that the benzene cation is formed by a charge transfer reaction from positive holes formed in the γ-irradiated silica gel to adsorbed benzene molecules. The formation of the benzene cation due to temperature elevation shows that adsorbed benzene molecules become mobile around −160°C. (Japan)

8926 UNSTABLE INTERMEDIATES. PART CIII. ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED MALONAMIDE AND RELATED COMPOUNDS. Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 20, 3205-8(1971).

Previous workers have presented strong evidence in favor of the formation of radicals of type RCONH in γ-irradiated malonamide and (cyanoacetyl)urea. The ESR spectra assigned to these radicals are characterized by a double splitting of about 80 G, and largely on the basis of this coupling, which was assigned to the NH proton, a σ-structure was postulated. This assignment is questioned particularly because the ^{14}N hyperfine tensor is characteristic of π-radicals. Comparison of single-crystal and powder spectra from irradiated malonamide with those from solids known to contain NH_4^+ radicals shows that this species is a possible alternative. Results for cyanoacetylurea rule out this assignment, but the data fit well with expectation for radicals of the type R(H)CN̈. (auth)

8927 RADIOLYSIS OF WATER. Rink, Hermann. Chem. Unserer Zeit; 5: No. 3, 90-5(Jun 1971). (In German).

Effects of ionizing radiation on water are surveyed. The review includes radical mechanisms, molecular mechanisms, spatial distribution of radicals, and quantity of radicals. As far as radiation is concerned, the following aspects are discussed: density of ionization, dose, pH, and oxygen concentration of other solubles. The importance of radiolysis for biology is briefly discussed. (H.B.G.)

8928 FREE RADICALS IN PYRIMIDINES: A SINGLE CRYSTAL OF DIHYDRO-6-METHYL-URACIL IRRADIATED AT 295°K. Bergene, Ragnar; Henriksen, Thormod (Univ. of Oslo). Int. J. Radiat. Biol.; 20: No. 3, 201-11(1971).

Single crystals of dihydro-6-methyluracil, indexed as 6-methylhydrouracil, grown from a D_2O solution were irradiated with electrons and the induced radicals studied by ESR. At room temperature, two different radicals were identified and their ESR parameters studied in detail. The radicals were formed by abstraction of a hydrogen atom from C_5 and C_6, respectively, leaving the unpaired spin density mainly to a $2p_z$ orbital or the same carbon atoms. The radical formed by abstraction of the C_6 hydrogen atom exhibited a relatively isotropic β-proton splitting. This radical had been observed in previous experiments on powder samples. The single crystal observations, however, showed a previously unknown nitrogen splitting for this radical. This observation was supported by INDO molecular orbital calculations. The other radical, which had not been observed previously, was similar to a radical (the 6-thymyl radical) found recently in thymine derivatives. (auth)

8929 RADIOLYSIS OF n-PROPANOL GLASS CONTAINING NAPHTHALENE OR DIPHENYL. Dainton, Frederick; Salmon, G. A.; Zucker, U. F. (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A; 325: No. 1560, 23-33(5 Oct 1971).

Gamma irradiation of glassy solutions of naphthalene (Naph) or diphenyl (ϕ_2), indexed as biphenyl, in n-propanol at 77°K produces both the anion of the solute and a neutral radical Naph. H or ϕ_2H. At 79°K the reaction, $Naph^- + EtCH_2OH \rightarrow Naph.H + EtCH_2O^-$, is slow but ϕ_2^- is stable, reacting rapidly with the solvent only at temperatures >90°K. These reactions can be accelerated by light which, as experiments with two-solute systems show, causes photodetachment of electrons from the anions and their capture by the second solute. The decay of Naph. H at 110 to 125°K, measured at $\lambda_{max} = 332$ nm, is second-order and the rate constant is given by the formula, $k = 10^{(13.0 \pm 1)} \exp [11.3 \pm 0.8 \text{ kJ mol}^{-1}/R(T-72)]$ $\text{mol}^{-1}\ \text{l s}^{-1}$. (auth)

8930 PULSE RADIOLYSIS STUDIES OF ELECTRON TRANSFER IN AQUEOUS QUINONE SOLUTIONS. Willson, R. L. (Mount Vernon Hospital, Northwood, Eng.). Trans. Faraday Soc.; 67: No. 586, 3020-9(Oct 1971).

The transient absorption spectra observed on pulse radiolysis of neutral aqueous solutions containing p-benzoquinone and excess methanol, ethanol, isopropanol, and formate, saturated with nitrous oxide are reported. The spectra are analogous to those obtained in solutions containing excess t-butanol and N_2, O_2, nicotinamide adenine dinucleotide, or thymine and are attributed to the semiquinone radical-anion formed by electron transfer reactions with bimolecular rate constants k = ca. 10^9−10^{10} $M^{-1}\ s^{-1}$. This assignment is supported by measurements of the acid dissociation constant of the absorbing product ($pK_\alpha = 4.1$) in solutions containing excess acetone and isopropanol. (auth)

8931 YIELDS OF EXCITED SINGLET AND TRIPLET STATES OF SOME AROMATICS IN THE PULSE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS. Baxendale, J. H.; Wardman, Peter (Univ. of Manchester, Eng.). Trans. Faraday Soc.; 67: No. 586, 2997-3007(Oct 1971).

The yields of excited singlet G(S) and total triplet, G(T), states of diphenyl, naphthalene, and anthracene produced by the pulse radiolysis of their solutions in cyclohexane were measured at concentrations of 0.5, 2.0, 5.0 and 10.0 mM. Triplet states were measured by absorption, and singlets by comparison of emissions with those of the same solute in benzene. For all solutes in benzene the emissions follow Stern−Volmer kinetics and kinetic parameters were obtained for energy transfer from the excited singlet of benzene to the solutes. For each solute the total yield of excited states $G(S) + G(T)_0$ is about the same as the yield of anions as calculated from establishing scavenging equations. The ratio $G(T)_0/G(S)$ is about 2.0 for diphenyl, 1.0 for naphthalene, and 2.0 for anthracene. (auth)

8932 RATE CONSTANTS AND RELATIVE YIELDS OF SOLVATED ELECTRONS IN CONCENTRATED SOLUTIONS. Rabani, J. (Hebrew Univ., Jerusalem). J. Chem. Soc., D: No. 21, 1353-4(1971).

Pulse radiolytic investigations provide evidence against the "dry electron" interpretation of previous results in ethanolic benzene and in aqueous phenol. (auth)

8933 HOMOLYTIC HALOGEN REPLACEMENT IN HALOGENOBENZENES BY RADIOLYTICALLY FORMED AQUEOUS HYDROGEN (TRITIUM) ATOMS. Brett, C. L.; Gold, V. (London, Univ.). J. Chem. Soc., D; No. 22, 1426-7(24 Nov 1971).

Replacement of halogen atoms by aqueous tritium atoms occurs in competition with hydrogen replacement, the relative importance of the two processes depending on the nature of the halogen and the concentration of added copper(II) ion. (auth)

8934 FORMATION OF RADICAL ANIONS BY X-IRRADIATION OF PURINE BASES IN ALKALINE GLASSES. Lion, Yves; van de Vorst, Albert (Univ., Liege). Int. J. Radiat. Phys. Chem.; 3: No. 41, 521-5(Dec 1971). (In French).

Measurements were made of the g-factors characterising the ESR spectra obtained for the radiolysis at 77°K of alkaline solutions (NaOH 2M. dm^{-3}) of purine bases. The dependence of the scatter $\Delta g = g'_{measured} - g_{free\ spin}$ on the lowest free orbital of the compounds considered is linear, which suggests the presence of negative radical ions. (auth)

8935 YIELDS OF e^-_{aq}, H, AND OH IN WATER EXPOSED TO EXCITED ARGON. Kongshaug, M. (Norsk Hydro Inst. for Cancer Research, Oslo). Nature (London) Phys. Sci.; 234: No.46, 57-8(15 Nov 1971).

In the studies described, de-aerated aqueous solutions of p-bromophenol and ferrocyanide were exposed to excited Ar atoms in a gas discharge system and yields of hydrated electrons e^-_{aq}, H-atoms and OH radicals were determined from observed yields of Br^- and ferrocyanide. The surface layers of 5 ml of de-aerated solution were exposed at 5 ± 2°C, and the gas flow speed was 12 l/min. The resulting rate of formation of H and OH was $\sim 8 \times 10^{-5}$ M/min, and within the range of doses and solute concentrations used the yields of Br^- and ferrocyanide were linear with dose. The reaction of H-atoms with bromophenol to give an equivalent amount of Br^- was the basis for determination of their yield, and the yield of OH radicals was obtained using ferrocyanide as an OH scavenger; it was found that the OH radicals appeared to follow the same type of kinetics as the H-atoms. For the same dose rate of excited argon exposure the bulk yields of e^-_{aq}, H-atoms, and OH radicals were found to be: $Ye^-_{aq} = (4.5 \pm 0.2) \times 10^{-6}$ M/min, $Y_H = (7.7 \pm 0.1) \times 10^{-5}$ M/min, and $Y_{OH} = (8.0 \pm 0.2) \times 10^{-5}$ M/min. Reaction mechanisms and kinetics are discussed. (UK)

8936 SOLVATED ELECTRONS IN LIQUID AND SOLID SOLUTIONS. Report on the 1971 Spring Discussion Meeting of the German Bunsen Society for Physical Chemistry, Herrenalb, Germany, March 29–31, 1971. Ber. Bunsenges. Phys. Chem.; 75: No. 7, 607-722(Jul 1971). (In German and English). (CONF-710334).

Papers and abstracts of papers presented at the meeting are included. Separate abstracts were prepared for 7 papers. (M.C.G.)

For abstracts of individual papers see: 8937–8943.

8937 ELECTRONS IN CONDENSED MEDIA. Dainton, F. S. (Oxford Univ.). Ber. Bunsenges. Phys. Chem.; 75: No. 7, 608-18(Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

The effects of changes of temperature and pressure and of illumination on the shape and position of the absorption spectrum and ESR saturation curve of electrons trapped in rigid or viscous liquid matrices are described. Data are presented to show that the Arrhenius equation does not adequately describe the influence of temperature on the rates of diffusion-controlled reactions of the solvated electrons in glass-forming liquids, and that pulse-radiolysis studies of these systems allow a rigorous test of theories of these reactions and in particular demonstrate the reality of the predicted phenomenon of time-dependent rate constants. The conclusions drawn from this information are: (1) the wide structureless optical spectrum of e^-_s and e^-_t is partly due to a distribution of electrons in holes of different configurations; (2) that the trapping of electrons is facilitated by the pre-existence in the medium of "voids" but that reorganization of some cavities occurs after electron capture; (3) an increase of temperature by increasing the possibility of rotational motion of molecules in the walls of the cavity facilitates both the relaxation of traps and the release of electrons from them and also increases the probability of retrapping a mobile-electron; (4) over a large temperature range $\log k = A - B/(T - T_0)$ where T_0 is the temperature below which rotation sufficient to permit translocation of molecules is impossible and B is inversely proportional to the thermal expansion coefficient of the liquid; (5) that quantum mechanical tunneling of solvated electrons occurs and is the major factor influencing the rate of reaction of e^-_s at temperatures in the vicinity of T_0, and (6) that absorption of light causes mobilization of e^-_t and hence photoconductivity and use of light of different wavelengths enables perturbation of the trap distribution. (auth)

8938 APPLICATIONS OF THE HYDRATED ELECTRON FOR STUDYING REACTION MECHANISMS IN ORGANIC AND INORGANIC CHEMISTRY. Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 75: No. 7, 622-3(Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

Production of hydrated electrons by pulse radiolysis and their reactions with various compounds were used to study chemical reaction mechanisms. (M.C.G.)

8939 CONTRIBUTION TO THE PROBLEM OF ELECTRON TRAPPING IN NON-POLAR SOLIDS. Magat, Michel (Univ. Paris, Orsay, France). Ber. Bunsenges. Phys. Chem.; 75: No. 7, 666-8(Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

The trapping of electrons in nonpolar solids is discussed in the light of the polaron model and the bubble model. Comparison between semiquantitative theory and some experimental data suggests that the bubble model is the better model for explaining the properties of trapped electrons. (auth)

8940 ELECTRON-HOLE PAIRS IN THE MECHANISM OF THE RADIATION CHEMISTRY OF NON-POLAR AND POLAR LIQUID SYSTEMS. Weiss, Joseph J. (Univ. of Newcastle upon Tyne, Eng.). Ber. Bunsenges. Phys. Chem.; 75: No. 7, 673-5 (Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

After absorption of radiation leading to ionization, in general, the electrons are first captured in an expanded orbit around the positive ions. In media of low dielectric constants, the resulting charge-transfer excitons are relatively long-lived and they can react themselves with suitable electron or hole scavengers. If it is taken into account that such electron-hole pairs diffuse in the medium after their creation, the experimentally observed dependence of the yield on the square root of the scavenger concentration can be derived. In polar media, e.g., water, such electron-hole pairs are very short-lived and tend to dissociate into electrons and holes in times of the order of picoseconds. The experiments of Hunt et al. are discussed and it is shown that the observed dependence of the initial yields of the solvated electrons on scavenger concentration can be accounted for if it is assumed that in the presence of scavengers, the formation of e^-_{solv} is only possible if, statistically speaking, a scavenger molecule is not sufficiently close to a radiation produced electron-hole pair to enable it to react with it. (auth)

8941 REACTIONS OF ELECTRONS IN IRRADIATED ICE. Eiben, K.; Wieczorek, H. (Kernforschungszentrum, Karlsruhe, Ger.). Ber. Bunsenges. Phys. Chem.; 75: No. 7, 676-8(Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

The reaction of radiation-produced electrons with excess protons in ice is discussed. Reactions of mobile as well as photo- or thermochemically delocalized electrons with aromatic carboxylic acids in glassy frozen alkali hydroxide solutions yielded stabilized anion radicals identified by their optical and ESR-spectra. The relative reactivities of the aromatic carboxylic acids differ considerably from those in aqueous solutions. Protonation of the anion radicals, known to occur rapidly in liquid polar systems, seemingly is not a significant process in the frozen solutions. A photochemically induced and reversible electron transfer between the anion radical of the benzoic acid and the trapping sites of the electrons was observed. (auth)

8942 SOLVENT DEPENDENCE OF THE OPTICAL ABSORPTION SPECTRUM OF THE SOLVATED ELECTRON. Dorfman, Leon M.; Jou, F. Y.; Wageman, R. (Ohio State Univ., Columbus). Ber. Bunsenges. Phys. Chem.; 75: No. 7, 681-5 (Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

With application of fast infrared detection to pulse radiolysis studies of the solvated electron, the optical absorption spectrum was observed into the wavelength region beyond 2000 mμ. It has

thus been possible to determine the spectrum in such weakly polar liquids as tetrahydrofuran, diethylamine, and others, and in binary solvent systems of tetrahydrofuran with other liquids. Data now available for a variety of liquids cover an enormous range with the maximum of the absorption band at 580 to 2100 mμ. In the following weakly polar liquids the band maxima are: tetrahydrofuran 2100 ± 50, diethylamine 1900 ± 80, dimethoxyethane 1900 ± 150, and ethyl ether 2050 ± 150 mμ. It has been shown for such liquids as ammonia and ethylenediamine that results from pulse radiolysis of the pure liquid and from alkali metal solutions lead to the same absorption band for the solvated electron. In all binary solvent systems studied, only a single absorption band was seen with λ_{max} intermediate to the maxima observed for the pure components. Most of the data suggest that selective solvation in microscopic domains of the individual component does not occur, and the observations do not seem to support those models that propose that the optical properties are determined only by solvation with a small number of molecules. In tetrahydrofuran–water solutions, however, the water is dominant in determining the optical properties, whereas the tetrahydrofuran is dominant in determining the dielectric properties. There thus appears to be some selective interaction with the water. The data now available for various liquids suggest that the spectral position of λ_{max} is determined by the structural class of the molecule as well as by the dielectric properties of the liquid. (auth)

8943 SOLVENT DEPENDENCE OF OPTICAL AND KINETIC PROPERTIES OF SOLVATED ELECTRONS IN WATER–AMMONIA MIXTURES. Olinger, R.; Schindewolf, U. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Ber. Bunsenges. Phys. Chem.; 74: No. 7, 693-6(Jul 1971).

From Meeting of the society for physical chemistry; Herrenalb, Germany (29 Mar 1971).

The absorption spectrum and lifetime of solvated electrons was determined in water–ammonia mixtures with special consideration of the temperature and pressure dependence. The solvated electrons were produced by pulse radiolysis. With increasing ammonia content the light absorption maximum of the solvated electrons shifted to longer wavelengths. The lifetime of the solvated electrons, restricted by the reaction with water, increased almost exponentially with the ammonia content whereas the activation energy and the activation volume decreased to negative values. The optical data indicate that there is a smooth transition from hydrated to ammoniated electrons and that the molar volume of the electrons increases continuously with the ammonia content. The kinetic data can be explained on this basis and under the assumption that the entropy of the solvated electrons is larger the higher their volume. (auth)

8944 REACTIONS OF HOT HYDROGEN ATOMS IN IRRADIATED C_6H_6–C_6H_{12} AND C_6H_6–CH_3OH MIXTURES. Avdonina, E. N. (Queen Mary Coll., London). J. Inorg. Nucl. Chem.; 33: No. 11, 3663-9(Nov 1971).

The data on recoil tritium atoms reactions in cyclohexane–benzene and methanol–benzene mixtures are used to estimate the hot H atom contribution to H_2 and low molecular weight hydrocarbon formation during the radiolysis of the same systems. The total H_2 yield from irradiated cyclohexane–benzene mixtures is interpreted in terms of abstraction by hot and thermal H atoms and "molecular" H_2 detachment from the cyclohexane molecule, this suggests that benzene does not affect the formation and decomposition of excited C_6H_{12} species giving rise to hot H atoms, but easily scavenges precursors of "molecular" H_2. (auth)

8945 PULSE RADIOLYSIS STUDY OF THE MECHANISM OF ELECTRON TRAPPING IN ALCOHOL GLASSES AT 77°K. Kevan, L. (Wayne State Univ., Detroit). Chem. Phys. Lett.; 11: No. 1, 140-2(15 Sep 1971).

Trapped electron spectra in pulse-irradiated 2-propanol glass at 77°K shift toward the blue on a μsec timescale. Solute effects indicate that molecular reorientation around the electron is responsible for the transient spectral shift rather than a redistribution of electrons among traps. (auth)

8946 MECHANISM OF FORMATION OF FREE RADICALS INDUCED IN NUCLEIC ACID BASES BY IONIZING RADIATION. Lion, Yves; van de Vorst, Albert (Univ., Liege). Int. J. Radiat. Phys. Chem.; 3: No. 41, 513-20(Dec 1971).

The reaction of trapped electrons with nucleic acid bases was studied by electron spin resonance and spectrophotometry. Electrons were generated at 77°K by radiolysis of 8 mol dm^{-3} NaOH. For adenine, guanine, and thymine the results showed that an intermediate step, corresponding probably to the anion stage, occurred in the formation of the hydrogen adduct radicals that were ultimately observed. The cytosine anion does not appear to protonate. The implications of these findings for γ radiolysis of the four bases are discussed. (auth)

8947 RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS OF INDOLE AND ITS DERIVATIVES. Iddon, B. (Univ. of Salford, Eng.); Phillips, G. O.; Robbins, K. E.; Davies, J. V. J. Chem. Soc., B: No. 10, 1887-92(1971).

2,2-Bis-(3-indolyl)indol-3(2H)-one and polymer are the major products derived by γ-irradiation of aqueous solutions of indole in argon, nitrous oxide, and oxygen. Small amounts of indoxyl, indoxyl red, indigo, and indirubin are also formed. Anthranilic acid appears to be produced in oxygen. A reaction pathway is discussed which accounts for the high G(−indole) values and the strong oxygen-dependence of these reactions. By use of pulse radiolysis, the absorption spectra were recorded for the transient hydroxyl radical adducts for indole, 2-, 3-, and 5-methylindole, 1,2- and 2,3-dimethylindole, and indoline. Rate constants for the reactions of hydroxyl radicals with a number of indoles were also measured. (auth)

8948 EPR STUDY OF RADICALS FORMED BY THE γ-IRRADIATION OF AMMONIA ADSORBED ON SILICA GEL. Brotikovskii, O. I.; Zhidomirov, G. M.; Kazanskii, V. B.; Mashchenko, A. I.; Shelimov, B. N. (Inst. of Organic Chemistry, Moscow). Kinet. Katal.; 12: No. 3, 700-5(May-Jun 1971). (In Russian).

Electron paramagnetic resonance (EPR) spectra of γ-irradiated ammonia adsorbed on silica gel suggested the presence of the radicals $^{14}NH_2$, $^{15}NH_2$, R-^{14}NH, and R-^{15}NH. The observed spectral features were explained by an incomplete neutralization of anisotropy of the g-factor with protons and the nitrogen nucleus. Adsorption models for the radicals NH_2 and R-NH are presented and discussed. (tr-auth)

8949 CONTINUOUS γ AND PULSE RADIOLYSIS OF AQUEOUS BENZENE SOLUTIONS: SOME REACTIONS OF THE HYDROXYCYCLOHEXADIENYL RADICAL. Mantaka, Anastasia (Democritus Nuclear Research Center, Athens); Marketos, D. G.; Stein, Gabriel. J. Phys. Chem.; 75: No. 25, 3886-9(9 Dec 1971).

The radiation chemistry of aqueous benzene solutions in the presence of N_2O was investigated using ^{60}Co γ-ray continuous irradiation (at varying benzene concentrations and at dose rates of 100 to 4000 rads min^{-1}) and 5 MeV, 200 mA, 0.3 or 1.5-μsec electron pulses. The products are identical in both cases. They are, under these conditions, mainly due to the reactions of the hydroxycyclohexadienyl radical (BOH). Allowing for absorption due to the corresponding H atom adduct (BH), the spectrum of BOH was determined. $\epsilon_{313}^{BOH} = (4.7 \pm 0.6) \times 10^3$ M^{-1} cm^{-1} at the maximum. The bimolecular rate constant k (2BOH → $(BOH)_2$) has the value of $(7 \pm 0.9) \times 10^8$ M^{-1} sec^{-1}. The final product observed is mainly the dimer $(BOH)_2$ which decomposes to give (phenol + benzene + H_2O) and (biphenyl + $2H_2O$). (auth)

8950 CONDUCTOMETRIC PULSE RADIOLYSIS DETERMINATION OF IONIC YIELDS AND NEUTRALIZATION KINETICS IN LIQUID ETHANOL. Rabani, J.; Graetzel, M.; Chaudhri, Shamim A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Phys. Chem.; 75: No. 25, 3893-4(9 Dec 1971).

Conductometric pulse radiolysis was used to determine the yields of e^-_{solv} and other negative ions such as $C_2H_5O^-$ in the radiolysis of ethanol. Ethanol containing benzyl chloride as electron scavenger was irradiated by a 0.3-μ sec pulse of 1.5-MeV electrons. In pure ethanol, the half-life of e^-_{th} was measured optically and found to be ~5 μsec. In the presence of $C_6H_5CH_2Cl$ no e^-_{th} signal could be observed. $G(e^-_{solv})$ was obtained as 1.8 ± 0.2 from the final value of the conductivity and the absorbed dose. (D.H.M.)

8951 NANOSECOND PULSE RADIOLYSIS STUDIES OF AQUEOUS THYMINE SOLUTIONS. Theard, Leslie M. (Gulf Radiation Tech., San Diego, Calif.); Peterson, Frank C.; Myers, L. S. Jr. J. Phys. Chem.; 75: No. 25, 3815-21(9 Dec 1971).

Nanosecond pulse radiolysis of aqueous thymine solutions was studied by producing optically detectable concentrations of transients with 10-nsec electron pulses from a Linac and employing an optical system with a signal rise time of 5 nsec. In deaerated 10^{-2} M thymine solutions containing 1 M ethanol at pH 6.0, thymine radical anion, T^- (λ_{max} 325 nm), is present at the end of the pulse and its decay over the subsequent 10^{-6} sec is only slight. At pH 4.0, T^- decays exponentially with a half-life of ca. 10^{-7} sec, and upon decreasing the pH to 3.5 the decay half-life decreases in proportion to the increase of acid concentration, suggesting that T^- decays via $T^- + H_3O^+_{aq} \rightarrow TH + H_2O$ with a reaction rate constant of $(6.4 \pm 0.3) \times 10^{10}$ M^{-1} sec^{-1}. The slow decay of T^- at pH 6.0 suggests that for the reaction $T^- + H_2O \rightarrow TH + OH^-$, $k \leq 10^4$ M^{-1} sec^{-1}. An absorption signal presumed attributable to TH is present following decay of the T^- signal, with λ_{max} also at 325 nm and an intensity about half that of T^-. Formation of the H-atom adduct of thymine, TH′, produced via the reaction of H + T →

TH′ was observed to occur during the period 10^{-8} to 10^{-6} sec following the pulse for deaerated 10^{-2} M thymine at pH 0.65. The rate constant for TH′ formation is $(6.8 \pm 0.2) \times 10^8$ M^{-1} sec^{-1}, and the absorption spectrum (λ_{max} 400 nm) of TH′ is different from that of TH. The data suggest that H-atom addition to thymine occurs at the 5,6 double bond while protonation of T^- occurs elsewhere. The submicrosecond decay of T^- and TOH resultant from their reactions with oxygen was observed; rate constants for the reactions are 4.3×10^9 and 1.9×10^9 M^{-1} sec^{-1}, respectively. (auth)

8952 E.P.R. SPECTROSCOPY OF THE RADICALS FORMED IN A SINGLE CRYSTAL OF 6-AZATHYMINE BY IRRADIATION. Herak, J. N. (Rudjer Boskovic Inst., Zagreb); Schoffa, G. Mol. Phys.; 22: No. 2, 379-83(1971).

Details of the method of crystal growth are given. These were irradiated by either γ or x rays, analyzed and the spectra recorded in three mutually perpendicular planes in 5° intervals. Spectra are illustrated of a γ-irradiated single crystal of undeuterated and deuterated 6-azathymine; no difference was observed in x-irradiated crystals. The nitrogen couplings were measured in some orientations of the field and are shown in graphical form. The ^{14}N coupling tensors were evaluated and are tabulated. The structure of the radicals present in the irradiated crystals is discussed. (UK)

8953 RADIATION CHEMISTRY OF SOME SULFONEPHTHALEIN DYES. Gupta, B. L.; Hart, Edwin J. (Bhabha Atomic Research Centre, Trombay, India. Argonne National Lab., Ill.). Radiat. Res.; 48: No. 1, 8-19(Oct 1971).

Reactions of hydrated electrons (e^-_{aq}) with Xylenol Orange, Thymol Blue, Cresol Red, Phenol Red, and p-benzoquinone and of the OH radical with Xylenol Orange were studied, using flash photolysis and gamma irradiation under conditions where the roles of e^-_{aq} and OH are emphasized. The rate constants of the reactions of e^-_{aq} with Xylenol Orange, Cresol Red, and p-benzoquinone at pH 11 are 5.2×10^9 M^{-1} sec^{-1}, 8.5×10^9 M^{-1} sec^{-1}, and 4.2×10^9 M^{-1} sec^{-1}, respectively; k(OH + Xylenol Orange) = 1.1×10^{10} M^{-1} sec^{-1}. Although Xylenol Orange reacts rapidly with e^-_{aq} the principal decolorization reaction is by the OH radical. The decolorization yields of Thymol Blue, Cresol Red, and Phenol Red are very small compared to $G(e^-_{aq})$. p-Benzoquinone is reduced to hydroquinone with a high yield in alkaline-high pressure H_2 solutions. A mechanism for the reactions of e^-_{aq} and OH with these dyes is proposed. (auth)

8954 PULSE RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. I. ABSORPTION SPECTRUM OF THE HYDRATED ELECTRON AT PRESSURES UP TO 6.3 KBAR. Hentz, Robert R.; Farhataziz; Hansen, Earl M. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 55: No. 10, 4974-9(15 Nov 1971).

A system for study of the pulse radiolysis of liquids at pressures up to 6.9 kbar is described. With this system the optical absorption spectrum of the hydrated electron was measured at 29 ± 3°C and applied pressures in the range 0 to 6.3 kbar. The spectrum shifts monotonically to shorter wavelengths with increase in applied pressure from 0 to 6.3 kbar. The transition energy at the absorption maximum, E_{max}, increases from 1.71 to 2.00 eV, and the bandwidth at half-maximum increases by ~28%. It was concluded that the extinction coefficient at the absorption maximum decreases by ~18% and, therefore, that the oscillator strength shows little or no pressure dependence. Values of E_{max} obtained in the present work and from a published study of the temperature dependence show a monotonic increase with increase in the static dielectric constant, D_s. It is suggested that the correlation between E_{max} and D_s is a consequence of a predominant influence on the structure of e^-_{aq} of an attractive force determined by the local dielectric constant of the first solvation shell. Being determined in a similar manner by the same physical factors, D_s and the local dielectric constant change in the same direction. (auth)

8955 ^{13}C HYPERFINE INTERACTIONS IN RADICALS FROM SOME CARBOXYLIC ACIDS. Laroff, Gary P.; Fessenden, Richard W. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 55: No. 10, 5000-8(15 Nov 1971).

The ESR spectra of four radicals of the type $R\dot{C}HCO_2^-$, four of the type $RC(O^-)CO_2^-$, and one each of the types $R_2\dot{C}CO_2^-$ and $ROHCCO_2^-$ were studied and the ^{13}C hyperfine constants determined. The radicals were produced by continuous, in situ radiolysis of basic aqueous solutions of the appropriate acids. In all cases the radicals bore at least two units of negative charge, and radicals labeled with ^{13}C at the natural abundance level were detectable because of the lowering of the recombination rate by this multiple charge. A typical radical of the first type is $\dot{C}H(CC_{2/4}$ (a^C_α = 31.44 G, a^C_β = 11.92 G) derived from malonate. Also studied were radicals from succinate, citrate, and the anion of 1,2,3-propanetricarboxylic acid. In all cases where a^C_α could be determined, the values are close to 30 G. The values of a^C_β were also rather constant, being in all cases in the range 10 to 13 G. The hyperfine constants of the γ carbons (substituents on β carbons) in this type of radical are consistent with an angular dependence $a^C_\gamma \cong 20 \cos^2\theta$. A typical radical of the second type is $CH_3\dot{C}(O^-)CO_2^-$ (a^C_α = 14.09 G, a^C_β = 8.19, 6.35 G). The small ^{13}C hyperfine constants of this type of radical (~7–14 G) demonstrate the planarity of these radicals at the α carbon. Also studied was the radical $^-O_2CCH_2\dot{O}CHCO_2^-$ for which a^C_α was found to be 26.45 G. The low value of a^C_α shows that this radical is planar at the radical site and hence can serve as a reference for the values of a^C_α in hydroxyalkyl and ketyl radicals. The hyperfine constants of the radicals $\dot{C}H_2CO_2^-$, $\dot{C}H(CO_2^-)_2$, and $H\dot{C}(O^-)CO_2^-$ are compared with values from INDO molecular orbital calculations. (auth)

8956 EPR OF TRAPPED H AND D ATOMS IN γ-IRRADIATED ACIDIC GLASSES. ANOMALOUS DIFFERENTIAL SATURATION OF HYPERFINE COMPONENTS VIA CROSS RELAXATION INDUCED BY PARAMAGNETIC METAL IONS. Wong, S. K.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). J. Chem. Phys.; 55: No. 10, 4940-7(15 Nov 1971).

Cross relaxation is suggested as the mechanism for the observed anomalous differential saturation of the hyperfine components of trapped D atoms in γ-irradiated acid glasses. The theory of cross relaxation was examined. Further experimental confirmation was obtained from a detailed investigation of the abnormal saturation of trapped D and H atoms induced by the presence of paramagnetic transition-metal cations deliberately added to the system. The metal cations have a much shorter spin–lattice relaxation time, and their resonances overlap to different degrees with the hyperfine components of the trapped D and H atoms. The quantitative effect of concentration of these added paramagnetic metal cations on the cross relaxation process was also examined. (auth)

8957 PRESSURE SHIFTS IN PROPERTIES OF SOLVATED ELECTRONS IN ALCOHOLS AND WATER. Robinson, M. G.; Jha, K. N.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys.; 55: No. 10, 4933-5(15 Nov 1971).

Pressure shifts of the optical absorption maxima of solvated electrons are, respectively, in electron volts per kilobar and nanometers per kilobar: in water 0.053 and −19; in ethanol 0.062 and −20; in methanol ~0.05 and −15. The half-width of the absorption spectrum of e^-_{solv} in water increased from 0.9 eV at 1 bar to 1.2 eV at 3.8 kbar. In both ethanol and methanol the half-lives were reduced by pressure. In ethanol $\Delta V^\ddagger(e^-_{solv} \rightarrow RO^-_{solv} + H) = -16$ cm^3 mol^{-1}. In water $\Delta V^\ddagger(e^-_{solv} + S \rightarrow S^-) \approx -1$ cm^3 mol^{-1}. (auth)

8958 POLYMORPHIC TRANSFORMATIONS IN γ-IRRADIATED AMINO ACIDS AND DIPEPTIDES. Kushelevsky, A. P.; Slifkin, M. A. (Univ. of Salford, Eng.). Radiat. Eff.; 11: No. 1, 29-32(Oct 1971).

There is an unexpected decrease in infrared absorption band intensities of amino acids and dipeptides on irradiation with γ rays at very high dose rates. The infrared evidence together with x-ray crystallographic studies leads to the postulation of weak bond formation which increases the degree of molecular association in the irradiated material. A marked increase in infrared absorption at low dose rate earlier reported was not observed. (auth)

8959 E.S.R. STUDY OF NO_2 IN X-IRRADIATED SODIUM NITRATE-^{17}O. Silver, Brian L. (Technion-Israel Inst. of Tech., Haifa); Koresh, J.; Schlick, S.; Luz, Z. Mol. Phys.; 22: No. 2, 225-31(1971).

The NO_2 radical was studied by ESR in x-irradiated single crystals of $NaNO_3$. At room temperature the spectrum was interpreted as due to NO_2 rotating about the C_3 axis of the parent NO_3^- ion. At 77°K the motion is frozen and the radical is trapped at three distinct sites in the crystal. ^{14}N and ^{17}O hyperfine tensors for both rotating and static NO_2 were measured. (auth)

8960 ELECTRONIC SPECTRA OF TRAPPED ELECTRONS IN ORGANIC GLASSES AT 4°K. II. ETHANOL–METHANOL MIXTURES. Hase, Hirotomo (Kyoto Univ., Osaka); Noda, Masato; Higashimura, Takenobu; Fueki, Kenji. J. Chem. Phys.; 55: No. 11, 5411-12(1 Dec 1971).

A study was made of the absorption spectra of trapped electrons produced by γ rays at 4°K in ethanol–methanol mixtures. One of the three absorption maxima always lies at 1500 nm, the same location as for the pure ethanol maximum. This suggests that there

still exist unrelaxed potential wells in the mixtures. Photobleaching by 1400-nm light and 650-nm light was studied; the results suggest that a portion of the electrons are shifted back and forth between relaxed and unrelaxed potential wells by infrared and visible light. (D.L.C.)

8961 EVIDENCE THAT e^-_{aq} + $H_3O^+_{aq}$ DOES NOT GIVE H-ATOMS, AND THAT THE MAJOR FRACTION OF THE RESIDUAL HYDROGEN IN γ RADIOLYZED WATER IS NOT H-ATOMS. Kongshaug, M. (Norsk Hydro Inst. for Cancer Research, Oslo); Steen, H. B.; Cercek, B. Nature (London) Phys. Sci.; 234: No. 48, 97-8(29 Nov 1971).

Evidence is claimed that, in contrast to general belief, the reaction of hydrated electrons with hydronium ions does not yield H atoms, and that the major fraction of the residual H in γ-irradiated water is not comprised of H atoms. These conclusions are based on measurements of the yield of Br^- ions in deaerated neutral and acid solutions of p-bromophenol (BrP) irradiated with 220-kV x rays, ^{60}Co γ rays, H atoms formed by a microwave discharge in H_2, and excited Ar atoms formed by a microwave discharge in Ar. Details are given of the experimental techniques adopted, together with a discussion of the results obtained and probable mechanisms. With regard to the residual hydrogen in irradiated water it appears that this involves at least two different species, and it is suggested that it consists of H atoms (G_H = 0.17) and H_3O_{aq} radicals ($G_{H_3O_{aq}}$ = 0.55 − 0.17 = 0.38. (UK)

8962 ELECTRON SPIN RESONANCE SPECTRUM OF X-IRRADIATED SINGLE CRYSTALS OF DIPHENYLPHOSPHINE OXIDE. Geoffroy, M.; Lucken, E. A. C. (Ecole de Chimie, Geneva). Mol. Phys.; 22: No. 2, 257-62(1971).

X irradiation of single crystals of $(C_6H_5)_2P(=O)H$ yields the $(C_6H_5)_2\dot{P}O$ radical, the phosphorus analogue of diphenyl nitroxide. The principal values of the ^{31}P hyperfine coupling constants are 1439 MHz, 929 MHz, and 908 MHz, which may be resolved into an isotropic component of 1092 MHz, and anisotropic components of 347 MHz, −163 MHz, and −184 MHz. This implies that, unlike diphenyl nitroxide, this radical is nonplanar (s/p ratio = 0.18, s-character = 0.11, p-character = 0.60). (auth)

8963 SEMIQUINONE FREE RADICALS: DETERMINATION OF ACID DISSOCIATION CONSTANTS BY PULSE RADIOLYSIS. Willson, R. L. (Mount Vernon Hospital, Northwood, Eng.). J. Chem. Soc., D; No. 20, 1249-50(20 Oct 1971).

The acid dissociation constants of the semiquinone free radicals of 2,5-dimethyl-p-benzoquinone, tetramethylbenzoquinone, 1,4-naphthaquinone, 2-methyl-1,4-naphthaquinone, and anthraquinone-2,6-disulphonate, were determined in water−isopropyl alcohol−acetone solutions (ca. 90% w/w water) by pulse radiolysis. (auth)

8964 PULSE RADIOLYSIS OF PENICILLAMINE IN AQUEOUS SOLUTION: THE THIYL RADICAL AND THE DISULPHIDE RADICAL ANION. Purdie, J. W.; Gillis, H. A.; Klassen, N. V. (National Research Council of Canada, Ottawa). J. Chem. Soc., D; No. 19, 1163-5(6 Oct 1971).

Penicillamine was subjected to pulsed electron radiolysis in solutions with pH in the range 5 to 9. The RS· radical and the $RSSR^-$ radical anion of penicillamine were found to have λ_{max} 330 nm, ϵ_{330} 1.22×10^3 M^{-1} cm^{-1} and λ_{max} 450 nm, ϵ_{450} 7.5×10^3 M^{-1} cm^{-1}, respectively, and K_1 for the equilibrium RS· + RS^- ⇌ $RSSR^-$ is 2.5×10^2 M^{-1} at pH 8. (auth)

8965 RADIOLYSIS OF LIQUID NITROGEN CONTAINING HYDROCARBONS. III. NITRILE FORMATION FROM SOLUTIONS OF ALKANES. Oka, Takefumi; Shindo, Tadashi; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: No. 8, 2274-5(Aug 1971).

Results of the radiolysis of liquid nitrogen containing simple alkanes are reported and the mechanisms of the formation of some of the nitrogenous products are discussed. The observed products for propane were acetonitrile, a trace of propionitrile, ethane, ethylene, isobutane, butane, 2,3-dimethylbutane, and/or 2-methylpentane, hexane, an unspecified basic compound, and a nonvolatile product. The observed products for ethane were acetonitrile, hydrogen cyanide, propane, acetylene, and butane. The basic products were not examined. The nitrogenous product observed for methane was hydrogen cyanide; the other products were not analyzed. (D.H.M.)

8966 GAS-PHASE RADIOLYSIS OF CYCLOHEPTATRIENE. Nakamura, Katsuyoshi; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). Bull. Chem. Soc. Jap.; 44: No. 8, 2090-5(Aug 1971).

The γ radiolysis of cycloheptatriene (CHT) in the gas phase was investigated as a function of the pressure (2 to 14 mmHg) and in the presence of various additives (NO, O_2, NH_3, N_2O, and C_3H_8). The G values obtained at 10.5 mmHg and at a total dose of 1.1×10^{19} eV are as follows: hydrogen, 0.50; methane, 0.16; acetylene, 1.52; cyclopentadiene, 0.29; benzene, 0.65; toluene, 1.68; dimers, 2.99. The yields of toluene and cyclopentadiene decrease with the pressure and are not appreciably affected by these additives; this suggests a contribution of the excited CHT molecules formed by direct excitation to their formation. The formation of dimers and benzene is affected by a radical scavenger (O_2,NO), indicating the importance of the radical processes. The reaction products obtained via a $C_7H_7^+$ ion, which is well known to be produced by the irradiation of CHT, were not observed, while in the radiolysis of CHT in the presence of benzene and a radical scavenger, biphenylmethane was produced, presumably by a reaction of the $C_7H_7^+$ ion with benzene. Therefore, it was assumed that the $C_7H_7^+$ ion produced from CHT does not contribute to the dimer formation, but may initiate the ionic polymerization. (auth)

8967 RARE-GAS-SENSITIZED RADIOLYSIS OF TOLUENE. Yamamoto, Yukio; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). Bull. Chem. Soc. Jap.; 44: No. 8, 2104-7(Aug 1971).

The Ar-, Kr-, and Xe-sensitized radiolyses of toluene was studied at room temperature in the gas phase. The discussion was concentrated on the formation of three isomers of methyldiphenylmethane (MDPM) (phenyltoylmethane), which, it had been suggested in a previous paper on the direct radiolysis of toluene, were formed by the ion-molecule reaction of $C_7H_7^+$ ions. The sensitization effect on the MDPM formation was extremely large in the case of Ar, and decreased in the order of Ar, Kr, and Xe. These results were explained in terms of charge transfer from these rare gases to toluene, resulting in the formation of the $C_7H_7^+$ ions. The isomer distribution of MDPM's in the rare-gas-sensitized radiolysis was considered on the basis of the reaction mechanism proposed previously. The sensitization effect on the formation of other products was also discussed briefly. (auth)

8968 ROLES OF THIYL RADICALS IN THE RADIOLYSIS OF A MIXED AQUEOUS SOLUTION OF CYSTEINE AND FORMATE: HYDROGEN ABSTRACTION FROM FORMATE AND THE FORMATION OF CARBON DIOXIDE. Morita, Makio; Sasai, Katsuro; Tajima, Makoto; Fujimaki, Masao (Tokyo Univ.). Bull. Chem. Soc. Jap.; 44: No. 8, 2257-8(Aug 1971).

Attempts were made to elucidate the role of thiyl radicals in the γ-radiolysis of aqueous solutions containing L-cysteine and formate, and the evidence was obtained for the abstraction of hydrogen and the acceleration of CO_2 formation from formate by cysteine thiyl radicals. (auth)

8969 REACTIVITY OF PENTACYANONITROSYL IONS OF TRANSITION ELEMENTS TOWARDS HYDRATED ELECTRONS AND HYDROXYL RADICALS. Jezowska-Trzebiatowska, B.; Kalecinska, E.; Kalecinski, J. (Univ., Wroclaw. Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 4, 265-75(1971).

The rate constants of the reactions of pentacyanonitrosyl complexes of Fe, Co, Mn, and Cr with e^-_{aq} and OH radicals were determined using nitrates and p-nitrosodimethylaniline (PNDA) as the competing scavengers for hydrated electrons and hydroxyl radicals, respectively. It was established that the high reactivities of 5-cyanonitrosyl cobaltate(III) and ferrate(III) toward the hydrated electrons and the low reactivities toward the hydroxyl radicals are caused by the weak positive charge of the NO group. The opposite is true of 5-cyanonitrosyl manganate(III) and chromate(III). It was shown that the rate constants of both the reduction and the oxidation of 5-cyanonitrosyl complexes depend on the stretching frequencies of the NO bond. (auth)

8970 RADIATION CHEMISTRY OF OXALIC ACID AND OXALATES. Draganic, I. G.; Gal, O. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Radiat. Res. Rev.; 3: No. 2-3, 167-207(Oct 1971).

Reactions of different forms of oxalic acid with primary products of water radiolysis in radiolysis of oxalates and oxalic acid in aqueous solutions, radiolysis in the solid state, and uses in chemical dosimetry are discussed. (111 references). (M.C.G.)

8971 RADIATION CHEMISTRY OF AQUEOUS AERATED FERROUS SULPHATE SOLUTION. Das, R. C. (Ravenshaw Coll., Cuttack, India). Radiat. Res. Rev.; 3: No. 2-3, 121-39 (Oct 1971).

The nature of intermediate species, the influence of reactant concentrations on ferric yields, determination of primary radical

and molecular yields of water, and radiolysis of $FeSO_4$ in the presence of organic compounds or other inorganic compounds are discussed. (109 references). (M.C.G.)

8972 KINETICS OF ELECTRON REACTIONS IN THE γ-IRRADIATED LIQUIDS ETHANE, PROPANE, ETHYLENE, PROPYLENE, AND CYCLOPROPANE: EFFECT OF MOLECULAR STRUCTURE. Robinson, M. G.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys.; 55: No. 12, 5644-50(15 Dec 1971).

The influence of molecular structure on the kinetics of electron reactions in liquids was studied by measuring the efficiency of electron scavenging in five C_2 and C_3 hydrocarbons at 183.K; γ radiation and nitrous oxide scavenger were used. The relative efficiencies of electron scavenging in the five liquids were in the decreasing order $C_2H_6 > C_3H_8 > c\text{-}C_3H_6 > C_3H_6 > C_2H_4$; choosing the efficiency in ethylene as unity, the relative values are about $40 > 17 > 2.7 > 1.3 > 1.0$, respectively. The results are analyzed according to both the stochastic and the "square root" models for radiolysis kinetics. The conclusions drawn from the two models agree with each other. The smaller efficiency of electron scavenging in the olefins, compared to that in the alkanes, is mainly due to the shorter ranges of the secondary electrons in the olefins. Energy degradation of the secondary electrons in ethylene is an order of magnitude more efficient than it is in liquid ethane. The difference between the behavior of an electron in a liquid monoolefin and that in the saturated analog decreases with increasing chain length. The behavior of cyclopropane falls between those of propane and propylene, which is consistent with the classical organic chemical reactivity of the compounds. There is no correlation between the electron range in the liquid and the magnitude of the permanent dipole moment of these molecules, but there is a correlation between the electron range and the nature of the polarizability of the molecules. (auth)

8973 EFFECT OF DOSE ON THE RADIOLYSIS OF GASEOUS ETHYLENE. Gawlowski, J.; Niedzielski, J.; Sobkowksi, J.; Zechowska, A. (Univ., Warsaw). Radiat. Eff.; 11: No. 2, 85-90(Nov 1971).

The yields of unsaturated products of γ radiolysis of ethylene in the gas-phase decreased markedly with the increase in total dose absorbed. Dose effects were particularly severe at conversions above ca 5×10^{-2}%. An ionic mechanism was assumed to explain this observation. Ions unreactive towards ethylene appeared to be far more reactive towards higher olefins, the rate constants being 4.5×10^{-13} cc molecule^{-1} sec^{-1}, and 7.0×10^{-13} cc molecule^{-1} sec^{-1}, for reactions with 1-butene and 1-hexene, respectively. However, the identity of these ions remains hypothetical at present. Compounds having high proton affinities protect higher olefins from an ionic attack, scavenging effectively ions responsible for their disappearance. (auth)

Radioisotope Production

Refer also to abstracts 8675, 9002, 9151, and 9574.

8974 (CONF-690426–, pp 21-9) PRODUCTION OF TRANSPLUTONIUM ELEMENTS IN THE INSTITUTE FOR RADIOCHEMISTRY. Seelmann-Eggebert, W. (Karlsruhe Univ. (West Germany)). 1969. (In German).

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

The nuclear research center at Karlsruhe synthesizes transuranium elements either through successive neutron capture or through nuclear reactions with deuterons and α particles. The reactor irradiation program aims at the production of about 100 mg of ^{244}Cm and several mg of ^{252}Cf. The present status of the project with respect to raw material, irradiation methods, and separation of the transuranium elements is discussed. For the second type of production, an isochronous cyclotron is available, which accelerates α particles to 100 and deuterons to 150 MeV. Neutron-deficient isotopes of elements from uranium to berkelium are produced and separated. The research aims at the production of new nuclides, nuclear data, and excitation functions as well as an improved system for the probability of fission and nuclear emission from highly excited nuclei. (H.B.G.)

8975 (CONF-690426–, pp 213-24) SOME RESEARCH ON TRANSURANIUM ELEMENTS AT THE INSTITUTE FOR RADIOCHEMISTRY AT MUNICH. Specht, Siegfried (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). 1969. (In German).

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

The production program for ^{242}Cm at the University of Munich is described. The separation process yields curium of sufficient purity within the means available to a teaching institution. The separation is performed by an ion exchange chromatography method employing a cation exchange resin and α-hydroxyisobutyric acid as elution medium. Details of the procedure are presented in four flow charts. (H.B.G.)

8976 (ORNL-tr-2430) DEVELOPMENT OF ^{131}I PRODUCTION TECHNIQUES. Constant, R. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from report BLG-442. 18p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 10653.

8977 PRODUCTION OF ^{238}Pu WITH MINIMUM ^{236}Pu CONTAMINATION. Lindsey, W. J. (Atomic Energy Commission, Washington, D. C.); Roggenkamp, P. L.; Woods, W. K. Nucl. Technol.; 13: No. 1, 78-82(Jan 1972).

Small-scale test irradiations of ^{237}Np in the Richland and Savannah River production reactors have provided substantial empirical information on the mechanisms for formation of ^{236}Pu. Application of this information to the design of larger-scale irradiations in the Savannah River high flux reactor resulted in successful production of 2 kg of ^{238}Pu meeting current isotopic specifications for the heart program. Further work is planned to develop practical technology of producing still larger amounts. The optimum location for the ^{237}Np target in the D_2O reflector of the high flux charge was established. Tests demonstrated that matrix material for the targets is an important variable, and that the use of aluminum should be avoided. Irradiations of kilogram quantities of ^{241}Am were completed and most of the resulting ^{242}Cm will be allowed to decay into ^{238}Pu before chemical processing (for about two years). However, small amounts of the irradiated ^{241}Am will be processed promptly to provide ^{242}Cm for decay into ultra-high purity ^{238}Pu. (auth)

8978 PREPARATION OF ^{242}Cm FROM NEUTRON IRRADIATED ^{241}Am. Sakanoue, Masanobu; Nakatani, Mitsuo (Kanazawa Univ., Japan). Radioisotopes (Tokyo); 20: No. 9, 422-6 (Sep 1971).

The target of ^{241}Am irradiated with thermal neutron flux was subjected to the cation ion-exchange resin separation to separate ^{242}Cm, fission products, and target ^{241}Am. The optimum conditions for ion-exchange chromatography were examined with cation exchange papers and by paper electrophoresis. The automatic recording device was applied to ascertain α emitters in the effluent. The radiochemically pure ^{242}Cm was obtained easily by this method. (auth)

8979 PREPARATION OF CARRIER-FREE ^{148}Gd (α-EMITTER) FROM PROTON-BOMBARDED EUROPIUM. Nakatani, Mitsuo; Sakanoue, Masanobu (Kanazawa Univ., Japan). Radioisotopes (Tokyo); 20: No. 9, 417-21(Sep 1971).

The preparation of ^{148}Gd, a low-energy α emitter, from proton-bombarded europium target was studied. Though the radiochemical procedures at the first step were the reduction of europium with zinc amalgam followed by the coprecipitation with barium sulfate as in the previous study, the purification of gadolinium was also carried out with a cation ion exchange resin. The existence of ^{153}Gd and ^{152}Gd was gamma-spectrometrically identified in the purified gadolinium fraction together with that of ^{148}Gd by α spectrometry. The nuclear reaction to form such nuclides and the method to obtain ^{148}Gd suitable as a tracer for trivalent actinide nuclides are discussed. (auth)

8980 ^{129}Cs PRODUCTION VIA THE $^{127}I(\alpha,2n)^{129}Cs$ REACTION AND ITS PREPARATION AS A RADIOPHARMACEUTICAL. Sodd, V. J. (Cincinnati General Hospital); Blue, J. W.; Scholz, K. L. Phys. Med. Biol.; 16: No. 4, 587-98(Oct 1971).

The production of carrier-free ^{129}Cs for medical use by the $(\alpha,2n)$ reaction on thick sodium iodide and iodine targets is reported. The yield curve for the $^{127}I(\alpha,2n)^{129}Cs$ reaction on thick single crystals of sodium iodide was determined at incident energies of 16 to 40 MeV. The maximum yield of 0.7 mCi/μA-h was obtained above about 36 MeV. Procedures for reducing contaminants at the bombardment of sodium iodide or iodine targets are described. Ge(Li) spectra of ^{129}Cs are presented showing previously unreported γ-energies at 266.9, 282.4, 492.6, 533.9, 624.3, and 864.7 keV. The half-life of ^{129}Cs was measured to be 32.9 ± 0.2 hours. Radiopharmaceutical procedures used to prepare the isotope for in vivo use are also presented. (auth)

8981 ISOTOPE PRODUCTION IN COMMERCIAL POWER REACTORS. Wood, P. M. (Union Carbide Corp., Oak Ridge,

Tenn.). Isotop. Radiat. Technol.; 9: No. 2, 129-33(Winter 1971-1972).

Isotope production in power reactors is now limited to ^{60}Co, but ^{238}Pu, ^{241}Am, ^{243}Am, ^{242}Cm, and ^{244}Cm are potential products. Calculated production quantities are presented. (auth)

8982 ^{128}Xe PRODUCTION PROCESS DEVELOPMENT. Haase, D. W. (Douglas United Nuclear, Inc., Richland, Wash.). Isotop. Radiat. Technol.; 9: No. 2, 150-3(Winter 1971-1972).

A process for producing the stable isotope ^{128}Xe has been developed and demonstrated by Douglas United Nuclear, Inc. Neutron irradiation of elemental iodine produces ^{128}Xe, which is separated and recovered in a vacuum system by cryogenic techniques. Approximately 212 ml (STP) of 99.8% ^{128}Xe was produced from 450 g of iodine irradiated to a neutron fluence of 5.4×10^{20} n/cm^2. This article is a summary of USAEC Report DUN-SA-145. (auth)

8983 EVALUATION OF NUCLEAR REACTIONS THAT PRODUCE ^{123}I IN THE CYCLOTRON. Sodd, V. J. (Division of Medical Radiation Exposure, Cincinnati); Scholz, K. L.; Blue, J. W.; Wellman, H. N. Isotop. Radiat. Technol.; 9: No. 2, 154-9 (Winter 1971-1972).

Various nuclear reactions and methods for producing ^{123}I are evaluated and compared. (auth)

8984 HIGH PRESSURE NONCATALYTIC METHOD FOR CYCLOTRON PRODUCTION OF ^{18}F. Hinn, G. M.; Nelp, W. B.; Weitkamp, W. G. (Washington Univ., Seattle). Int. J. Appl. Radiat. Isotop.; 22: No. 11, 699-700(Nov 1971).

A simple high-pressure method for the production of radiopharmaceutical grade ^{18}F is described. A titanium target plate was designed to withstand internal pressures up to 160 lb/in^2. Consequently, catalytic recombination of H_2 and O_2 formed during production is not required. Yields of 6.2 mCi/μA hr or 194 mCi/75 min at a beam current of 25 μA were attained by bombarding water with 42 MeV α particles. At the end of bombardment the target's internal pressure forced the target water through a millipore filter and into a sterile collection vial. Negligible amounts of radiocontaminants were detected from recoil reactions off the titanium foil. The final product was sterile, pyrogen free and showed good localization in bone. (UK)

8985 PREPARATION OF CARRIER-FREE ^{203}Pb FOR MEDICAL USE. Chackett, G. A. (Univ. of Birmingham, Eng.); Chackett, K. F.; Welborn, J. B. Int. J. Appl. Radiat. Isotop.; 22: No. 11, 715-16(Nov 1971).

A method for preparation of ^{203}Pb in a form suitable for medical use was developed. This lead isotope is the most useful known one for use as a tracer in vivo. The initial reaction $^{203}Tl(^3He,3n)^{203}Bi$ using the 29 MeV external ^3He beam of a cyclotron and subsequent chemical separation is described. The results of testing the resultant samples for contamination are given. The overall yield of ^{203}Pb amounted to 10 μCi/hr bombardment. It is calculated that a whole body dose from the complete decay of 100 μCi uniformly distributed in the body would be less than 30 mrad. (UK)

Recoil Production and Reactions

Refer also to abstracts 8993–8995.

8986 THEORETICAL STUDY OF INELASTIC COLLISIONS OF HOT ATOMS. Baer, M. (Univ. of Houston, Tex.). Chem. Phys. Lett.; 11: No. 2, 229-32(1 Oct 1971).

Use was made of the integral-equation approach to study inelastic collisions so frequently encountered in hot-atom chemistry. To do this a few assumptions were made, which on the one hand enable the analytic derivation and on the other hand are still real enough in the sense that the solution obtained is valid and meaningful. The inelasticity in the collision between a hot atom and a reactive molecule manifests itself as a parameter that can be defined only by analogy as the average energy loss in an inelastic collision. (auth)

8987 REACTIONS OF RECOIL TRITIUM ATOMS WITH 1-BUTENE AND cis-2-BUTENE. AVERAGE ENERGY OF THE ADDITION REACTION. Kushner, Richard; Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Phys. Chem.; 75: No. 25, 3771-81(9 Dec 1971).

Consistent yields of propylene-t and $CH_2=CHT$ are found from recoil tritium reactions with 1-butene in O_2-scavenged, H_2S-scavenged, and unscavenged experiments. A large yield of n-C_4H_9T in the H_2S system confirms that substantial yields of butyl-t radicals are collisionally stabilized prior to decomposition to the smaller olefinic products. Similar observations are made with cis-2-butene as the parent molecule. Pressure-dependent studies show a complementary relationship between the yields of the stabilization product (n-C_4H_9T) and the decomposition products ($CH_2=CHT$ and $CH_2TCH=CH_2$ from 1-butene; $CH_3CH=CHT$ from cis-2-butene). Pressure-dependent decomposition of the labeled parent molecules is also observed. From calculated rate constants for butyl-t radical decomposition, the median kinetic energy of tritium atoms undergoing addition to the olefinic positions is estimated as <0.5 eV, far below the median energies for energetic T-for-H or T-for-CH_3 substitution reactions. The relative yields of all tritiated products from T* reactions with butene (except the abstraction product, HT) are essentially independent of O_2/butene mole fraction over the range to >70% O_2. (auth)

8988 RECOIL TRITIUM REACTIONS WITH CYCLOBUTANE-d_8. EXCITATION ENERGIES ACCOMPANYING SUBSTITUTION OF ENERGETIC TRITIUM FOR DEUTERIUM. Hosaka, Akio; Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Phys. Chem.; 75: No. 25, 3781-90(9 Dec 1971).

The median residual excitation energy left on c-$C_4D_7T^*$ following the energetic substitution of T-for-D in c-C_4D_8 is essentially the same (±0.2 eV) as for c-$C_4H_7T^*$ from T-for-H in c-C_4H_8 and is estimated to be 5 eV. The fraction of excited c-$C_4D_7T^*$ molecules which are collisionally stabilized is higher than for c-$C_4H_7T^*$ at the same pressure because of the fourfold faster decomposition of the protonated species for equal excitation energies. The percent collisional stabilization is about 60 for c-$C_4H_7T^*$ and 67 for c-$C_4D_7T^*$ at 1 atm pressure. The percent stabilization is about 83 in the liquid phase and 95 in the solid at −196° for both c-$C_4H_7T^*$ and c-$C_4D_7T^*$. The temperature effect on these decomposition reactions is ≤2% over the range 24 to 125°. (auth)

8989 REACTIONS OF ENERGETIC CARBON ATOMS PRODUCED BY NUCLEAR REACTIONS. Finn, Ronald Dennet. Blacksburg, Va.; Virginia Polytechnic Inst. (1970). 186p. University Microfilms Order No. 71-19,343.

Thesis.

The reactions of ^{14}C recoil species produced by the $^{14}N(n,p)^{14}C$ nuclear reaction were studied in magnesium nitride. The major reaction products, observed upon dissolution in water, are ^{14}C labelled methane, cyanide and cyanamide. Thermal annealing of the neutron irradiated magnesium nitride resulted in a sharp decline of cyanide and cyanamide yields and a new product, ^{14}C-labeled methylenimine, was observed. This latter product comprised up to 65% of the total ^{14}C activity in samples annealed at 500°C for 2.5 days. The product distribution was found to be a function of the pH of the aqueous solvent used for dissolution. Highly energetic ^{11}C atoms were generated in perfluorocarbon–oxygen mixtures using the 33-MeV proton beam of the Brookhaven National Laboratory 60-inch cyclotron for the $^{12}C(p,pn)^{11}C$ nuclear reaction. Carbon-11-labeled carbon monoxide and carbon dioxide composed 80 to 95% of the total ^{11}C activity produced. The increasing amount of $^{11}CO_2$ observed at radiation doses of 10^{-4} eV/molecule and higher was found to be formed by radiation-induced oxidation of ^{11}CO, which is formed either directly or via a fluorine-containing intermediate. The variation in yields of ^{11}C-labeled products from the reaction of recoil carbon species with ethane and cyclopropane (with helium and enon moderation) systems was studied as a function of total gas pressure. A systematic investigation into the preparation of high specific activity ^{11}C-labeled cyanide was undertaken. Methods of labeling cyanide, both directly utilizing metallic cyanides and by hot atom reactions, were studied with a view toward optimization of irradiation conditions. In order to optimize irradiation conditions, the yield of hydrogen cyanide was studied as a function of proton energy, radiolytic effects, dose rate dependency, and total absorbed. (Diss. Abstr.)

8990 REACTIONS OF IODINE ACTIVATED BY THE NEUTRON CAPTURE PROCESS IN LIQUID AND SOLID ALKANES AND ALKENES. Ayres, Robert Leroy. Lincoln, Neb.; Univ. of Nebraska (1971). 245p. University Microfilms Order No. 71-19,468.

Thesis.

A gas chromatograph was designed and constructed specifically for analysis of various organic halide products. The instrument was of a dual-column design with temperature-programming capabilities and a specially constructed flow-through window proportional counter for the detection of the products possessing a radioactive label. The influence of exchange and other experimental parameters on the radiative neutron capture induced organic yields of iodine in "pure" alkyl iodides was investigated. The $^{127}I(n,\gamma)^{128}I$-induced yields of organically bound iodine in the liquid C_1 to C_4 alkyl iodides studied were found to exhibit, to varying degrees, a dependence on exchange reactions, accompanying γ radiolysis, and phase. In the absence of and/or cor-

rected for the contributions of exchange and radiolysis the $^{127}I(n,\gamma)^{128}I$-induced organic yields in liquid methyl, ethyl, n-propyl, and n-butyl iodide are 57, 41, 48, and 48%, respectively. The corresponding yields of the polycrystalline alkyl iodide solids at 77°K are identical to the liquid state values; however, the yields for glassy normal propyl and butyl iodide are 8 to 12% higher than their corresponding polycrystalline and liquid state values. The kinetics of the addition of iodine to 1-pentene, cis and trans-2-pentenes, 2-methyl-1-butene, and 2-methyl-2-butene were studied using ^{131}I-labeled iodine. Using the information accumulated in the previous studies, the radiative-neutron-capture-induced yields of iodine and the resultant product distributions were determined in n-pentane, 1-pentene, and the cis and trans-2-pentenes as functions of additive concentration and irradiation time. The organic yields of the four C_5 isomers studied were found to decrease in the order 1-pentene = cis-2-pentene > trans-2-pentene > n-pentane. Radiolysis-produced ^{131}I products in these systems were determined and compared with the corresponding products produced by the nuclear activation process. Significant differences were found to exist between the observed product distributions resulting from the two dissimilar processes. It was concluded that these differences must be due to ion–molecule reactions occurring as a result of the internal conversion and subsequent Auger process accompanying the (n,γ) activation of iodine. The organic yields of iodine resulting from the $^{127}I(n,\gamma)^{128}I$ reactions in polycrystalline n-hexane were studied as a function of I_2 concentration. Comparison with similar studies in cyclohexane and benzene show that under conditions of monomolecular dispersion, the three structurally dissimilar hydrocarbons possess approximately equal preference for either organic or inorganic combination. Constant organic yields in n-hexane between 0.001 and 0.02 mole percent I_2 indicate the formation of preferred $(I_2)_n$ cluster sizes and/or similar numbers of molecules at sites in the polycrystalline n-hexane matrix. The solid state organic yields were found to be independent of isotope and mode of activation. Various repurification procedures and additives were employed to determine the necessary and sufficient procedures required to obtain meaningful experimental data. (Diss. Abstr. Int., B)

Radiochemistry

Refer also to abstracts 8876, 8986, and 9560.

8991 (NP–19125) CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. Bibliography, 1970. Adloff, J. P. (Strasbourg Univ. (France). Laboratoire de Chimie Nucleaire). 36p. (In several languages). Dep. NTIS (U. S. Sales Only).

A total of 218 references are presented in alphabetic order. Indexes of the elements and isotopes studied and an alphabetic list of authors are also given. (auth)

8992 PRINCIPLES OF RADIOCHEMISTRY. McKay, H. A. C. London: Butterworths (1971). 550p. Pound 13.

The subject is dealt with under the following headings: The nucleus and radioactivity (properties of the nucleus, basic features of radioactivity, radioactive decay processes, the radiations emitted by radioactive substances, detecting and measuring techniques, handling of radioactive materials). Rates and energies of radioactive decay (the radioactive decay law, determination of half-lives, the energy released in radioactive decay, theory of decay rates). Nuclear reactions (general features, methods of carrying out nuclear reactions, nuclear reaction yields and mechanisms, the Moessbauer effect, thermonuclear reactions). The occurrence and preparation of radioactive substances (natural products, artificial products, purity considerations, selection and availability of radionuclides, new elements, separated isotopes, radioactivity in the environment). Radiotracer principles and analytical applications (tracers, tracer kinetics, radiometric analysis, isotope dilution, radioactivation). Physicochemical applications of radiotracers (vapor pressure, solubility, partition between phases and its application in separation processes, surface phenomena at solid-liquid interfaces, surface phenomena at solid-gas interfaces). Radiotracers in the study of chemical reactions (exchange reactions, kinetic isotope effects, reaction pathways, tracing of individual atoms in reactions). Chemical effects of nuclear transformations (general introduction, chemical effects associated with α-decay, chemical effects with β-decay, chemical effects associated with isomeric transitions, chemical effects associated with nuclear reactions in which Z changes, chemical effects associated with nuclear reactions at constant Z, chemical effects associated with fission). (UK)

8993 AROMATIC SUBSTITUTION IN THE GAS PHASE. PART II. REACTIONS OF THE HELIUM TRITIIDE ION WITH ANISOLE, t-BUTYLBENZENE, AND ααα-TRIFLUOROTOLUENE. Cacace, Fulvio; Cipollini, Romano; Ciranni, Giovanna (Univ., Rome). J. Chem. Soc., B; No. 11, 2089-92(1971).

The study of the gas-phase reactions of the HeT^+ ion from the β-decay of molecular tritium was extended to anisole, t-butylbenzene, and ααα-trifluorotoluene. A mechanism based on exothermic triton transfer from the gaseous Brønsted acid HeT^+ to the aromatic substrate is used to account for the formation of the tritiated products, and for the distribution of tritium, which is found mainly in the ortho positions of anisole and in the meta positions of ααα-trifluorotoluene. (auth)

8994 AROMATIC SUBSTITUTION IN THE GAS PHASE. PART I. REACTION OF THE HELIUM TRITIIDE MOLECULAR ION WITH HALOGENOBENZENES. Cacace, Fulvio; Perez, Giorgio (Univ., Rome). J. Chem. Soc., B; No. 11, 2086-9 (1971).

The results of a study of the reactions of the powerful Brønsted acid, the HeT^+ ion from the β-decay of molecular tritium, with gaseous fluorobenzene, chlorobenzene, and bromobenzene are reported. In all the systems investigated, the tritiated halogenobenzene is the major product, and is accompanied, except in the case of fluorobenzene, by smaller amounts of tritiated benzene. The nature and the yields of the products, and their intramolecular tritium distribution, suggest that reaction is analogous to electrophilic substitutions occurring in solution. Mechanisms are discussed. (auth)

8995 REACTIONS OF SELECTED HALOGENS AND INTERHALOGENS ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION WITH CONDENSED STATE CYCLOPENTANE AND AROMATIC HYDROCARBONS. Kemnitz, Ernest John Jr. Lincoln, Neb.; Univ. of Nebraska (1971). 151p. University Microfilms Order No. 71-19,495. Thesis.

Cyclopentane, benzene, and selected alkylbenzenes were probed both in the liquid and solid phases with nuclear processes induced by the neutron activation of one or more of the following species: $^{127}I_2$, $^{129}I_2$, Br_2, ICl, and IBr. Of particular interest in each of the systems were the following: isotope effects due to radiative neutron capture (n,γ) and isomeric transition (IT) processes; individual comparative scavenging effects in the liquid phase systems of the various halogens and interhalogens; crystalline structure at 77°K; and product distributions of organic halides. The organic yields due to the $^{127}I(n,\gamma)^{128}I$ and $^{130}I^m(IT)^{130}I$ processes in liquid cyclopentane were about 1.2 times greater than those due to the $^{129}I(n,\gamma)^{130}I + {}^{130m}I$ processes, whereas no differences were found when benzene and alkylbenzene were used as solvents. The product distribution was seemingly independent of the nuclear process in all the solvents employed, which lends support to Willard's autoradiation hypothesis. Using ICl in solid state systems, it was found that ^{38}Cl organic yields were useful in determining concentrations at which clustering or fractional crystallization occurred, while ^{128}I organic yields were seemingly misleading. In the Br_2–benzene system at 77°K, two O. Y. plateaus appeared with the isotopes studied, producing different but parallel curves. The lower plateau region between 5×10^{-1} and 5×10^{-2} mf Br_2 was interpreted as a region of uniform 1:1 complex plus pure solvent. The higher plateau region, generally below 5×10^{-4} mf Br_2, was interpreted here to be a monomolecular dispersion of Br_2 in benzene. The constant 21 ± 1% organic yield of ^{38}Cl at all concentrations of ICl in benzene up to saturation supports this view. The study of isotope effects in solid state systems was found to require extremely high purity components. Only the Br_2–benzene gave reliable data for this reason. The $^{79}Br(n,\gamma)^{80m}Br$, $^{81}Br(n,\gamma)^{82}Br + {}^{82m}Br$, and $^{82m}Br(IT)^{82}Br$ processes each produced a different organic yield at a given concentration of Br_2. In the liquid state, where organic yields were found to be much less sensitive to trace impurities, scavenging was found in mixed- and interhalogen-benzene systems but not in I_2– and Br_2–benzene systems. ^{38}Cl organic yields were not affected by phase or the presence of iodine while bromine organic yields lowered in the presence of iodine. ^{128}I organic yields were enhanced in the presence of chlorine and bromine, probably due to an increase in radical formation. ^{128}I and ^{38}Cl organic yields in solid state I_2– and ICl–alkylbenzene systems resembled those in the analogous systems of benzene, indicating complex formation. The product distribution of the I_2–alkylbenzene systems indicated that the alkyl side chains are quite vulnerable to attack by hot atom processes. Methyl iodide was the major product in the several alkylbenzenes studied except in the case of ethylbenzene where ethyl iodide was equally abundant. Interestingly, a large amount of unstable, unlabeled organic iodide was formed in the I_2–ethylbenzene, –cumene and –tert-butylbenzene systems. (Diss. Abstr. Int., B)

Separation Processes

Refer also to abstracts 8675, 8750, 8871, 8878, 8881, 8903, 9085, 9146, 9148, 9705, and 10902.

8996 (ANL-7841) CHEMICAL ENGINEERING DIVISION FUEL CYCLE TECHNOLOGY QUARTERLY REPORT, APRIL, MAY, JUNE 1971. Webster, D. S.; Jonke, A. A.; Bernstein, G. J.; Levitz, N. M.; Pierce, R. D.; Steindler, M. J.; Vogel, R. C. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 62p. Dep. NTIS.

During the period April through Jun 1971, work was done in the following areas: (1) development of zinc decladding and melt decladding processes for the preparation of steel-clad LMFBR oxide fuel for acid dissolution, (2) study of the crystallization behavior of uranyl nitrate–plutonium nitrate–nitric acid solutions under consideration as feed solutions for a fluidized-bed process to prepare U–Pu oxides from their nitrates by denitration, (3) initial runs with uranyl nitrate to study the operability of a new denitration pilot plant, (4) evaluation of the precision of an x-ray fluorescence analytical method for determining Th/U ratio in ThO_2–UO_2 (a stand-in for UO_2–PuO_2), and (5) continued investigation of the performance characteristics of a centrifugal contactor for the plutonium isolation steps in the solvent extraction of LMFBR fuels. (auth)

8997 (BARC-571) STUDY ON RECOVERY OF PROMETHIUM FROM FISSION PRODUCT WASTE. Shukla, J. P.; Chandrasekharan, E. S.; Rengan, K.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 17p. Dep. NTIS (U. S. Sales Only).

Results of experiments carried out to evolve a simple procedure for recovery of fission product promethium-147 from nuclear fuel reprocessing wastes are summarized. Preliminary purification of Pm from associated fission products is readily accomplished by a manganese dioxide column adsorption. Final purification of the Pm fraction from other rare earth constituents was achieved by using either a cation or an anion exchanger. Relative merits of both techniques are briefly discussed. (auth)

8998 (BNWL-B-116) DISSOLUTION OF BURNED ZPPR FUEL IN NITRIC ACID SOLUTIONS. (Battelle Pacific Northwest Labs., Richland, Wash.). Nov 1971. Contract AT(45-1)-1830. 18p. Dep. NTIS.

The dissolution properties of burned ZPPR fuel (oxide) in nitric acid solutions were investigated. It appears possible to obtain complete dissolution of ZPPR oxide and simultaneously provide a suitable feed solution for the Plutonium Reclamation Facility separations plant. The fuel is a stainless steel-clad ternary alloy of depleted uranium, plutonium, and molybdenum. The scrap was burned to form the oxide. Dissolution rate tests indicated that about 85 wt % of the PuO_2 present is dissolved after an exposure of 10 to 15 minutes to boiling 15.5 M HNO_3–0.65 M HF solution. However, the remaining 15 wt % of the PuO_2 was quite refractory and required reflux for 3 to 4 hours for complete dissolution. This behavior also occurred when the 12.2 M HNO_3–0.2 M NaF acid solution designated for use with the Purex dissolution flowsheet was used. (M.C.G.)

8999 (CONF-690426–, pp 54-90) RECENT ADVANCES IN THE SEPARATION OF THE TRANSURANIUM ELEMENTS. Ferguson, D. E. (Oak Ridge National Lab., Tenn.). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

The engineering aspects of separation technology are discussed in the following areas: the present status of transuranium element production in the United States; the techniques now in use in the Transuranium Processing Plant (TRU); a high pressure ion exchange technique for separating transplutonium elements; and the chemistry of the transuranium elements in a reductive extraction process being considered for processing of the Molten Salt Breeder Reactor. (D.H.M.)

9000 (CONF-690426–, pp 91-115) SEPARATION OF TRIVALENT ACTINIDE AND LANTHANIDE ELEMENTS IN NITRATE MEDIUM. Koehly, G.; Berger, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

Actinide–lanthanide separation was demonstrated by countercurrent experiments using tridodecylammonium nitrate and synthetic solutions containing diethylenetriaminepentaacetic acid (DTPA) with satisfactory results. Using 6 mixer-settlers for stripping and 6 for scrubbing, a decontamination factor greater than 100 was obtained for americium and promethium. As far as organic and aqueous media are concerned, the application of these techniques to americium–curium separation gives a homogeneous process throughout the transuranium separations. (auth)

9001 (CONF-690426–, pp 134-42) PROBLEMS IN MASS-SEPARATION OF THE ACTINIDES. Ihle, H. R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

A brief review on the principles of electromagnetic mass separation is presented and particular problems about laboratory separators capable of separating heavy nuclides are discussed. Results obtained with a new instrument are also presented. (D.H.M.)

9002 (CONF-690426–, pp 169-91) RESEARCH ON TRANSPLUTONIUM ELEMENT CHEMISTRY AT THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS. Mueller, W. 1969.

From Symposium on transuranium element chemistry; Liege, Belgium (21 Apr 1969).

A short survey is given on separation, preparative, and analytical chemistry studies carried out in the field of transplutonium elements. This work involves separation of trivalent actinides from lanthanides and from each other, the preparation of americium metal, the analytical chemistry of americium and the isotope analysis of transplutonium elements. Some results of the research work were applied to the processing of two sets of irradiated ^{241}Am targets. Part of the ^{242}Cm recovered from targets exposed to an integrated flux of 1×10^{21} n/cm^2 was used to fuel a radionuclide battery in order to demonstrate the potential application of transplutonium nuclides for power production. (auth)

9003 (DOCKET-406622-3) SHIRLEY BASIN URANIUM MILL. Discussions and Findings Relative to Suspension of the Operating License Pending NEPA Environmental Review. (Division of Materials and Licensing (AEC), Washington, D. C.). 18 Nov 1971. 14p. Dep. NTIS.

Information is presented in relation to the decision not to suspend operation pending completion of the NEPA environmental review. Environmental impact during the prospective review period, foreclosure of alternatives, and cost of suspending operations are discussed. (M.C.G.)

9004 (DOCKET-408084-2) URANIUM CONCENTRATOR. Supplemental Environmental Report, Operating License Stage. (Rio Algom Corp., Moab, Utah). Nov 1971. 331p. Dep. NTIS.

Mine development and construction of surface facilities, including the concentrator, are being carried out. The principal areas of environmental effect are discussed and proposed methods of detecting and controlling anticipated adverse environmental effects are described. Environment of the area, planned operations, environmental regulations and effects, and a benefit-cost analysis are discussed. (M.C.G.)

9005 (DOCKET-50201-94) WEST VALLEY REPROCESSING PLANT. Technical Specifications for Category 10 Fuel, Proposed Change. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 12 Nov 1971. 8p. Dep. NTIS.

The specification to establish limits to govern the dissolver charging operation when processing Category 10 fuel is discussed. The maximum allowable ^{235}U equivalent concentrations are shown in graph form. Concentration limits in the rework evaporator and the evaporator feed tank are also considered. (M.C.G.)

9006 (DOCKET-50201-95) WEST VALLEY REPROCESSING PLANT. Investigation of Sources of Strontium Activity to the Interceptors. (Nuclear Fuel Services, Inc., Rockville, Md.). 1 Dec 1971. 11p. Dep. NTIS.

Sources of ^{90}Sr activity in the Low-Level Liquid Waste System were investigated. Analysis of samples taken from various parts of the plant showed that the ^{90}Sr present in the low-level waste water comes from essentially 6 sources within the plant: three continuous (acid recovery system overheads, shear gland water, general purpose evaporator overheads) and three intermittent (ventilation washer room, acid recovery system leakage, cask decontamination pit) sources. Two sources were eliminated and modifications to the system will eliminate 95% of these ^{90}Sr releases. (M.C.G.)

9007 (DOCKET-50201-96) WEST VALLEY REPROCESSING PLANT. Management of Low Level Liquid Effluent During

the SEFOR Campaign. ([Nuclear Fuel Services, Inc., West Valley, N. Y.]). 1 Dec 1971. 3p. Dep. NTIS.

SEFOR scrap is a mixture of U and Pu oxides from fuel rod production. The Pu is recovered in a waste processing campaign. Fission product input into the low-level liquid effluent system during this processing is discussed. (M.C.G.)

9008 (DOCKET-50201-97) WEST VALLEY REPROCESSING PLANT. Six Months Summary on the Low Level Liquid Waste Treatment Facility. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 29 Nov 1971. 34p. Dep. NTIS.

The performance of the Low-Level Waste Treatment Plant during the first 6 months of operation, the difficulties encountered, the development work being performed, and the projected performance are summarized. (M.C.G.)

9009 (DOCKET-50201-98) WEST VALLEY REPROCESSING PLANT. Low Level Liquid Wastes. (Nuclear Fuels Services, Inc., Rockville, Md.). 8 Dec 1971. 8p. Dep. NTIS.

Further efforts planned to improve the performance of the low-level liquid waste system are described. Resin degradation in the ion-exchange beds during nitric acid regeneration is discussed. Reducing the levels of ^{134}Cs, ^{137}Cs, ^{89}Sr, and ^{90}Sr released is the goal of the work. (M.C.G.)

9010 (DOCKET-50201-99) WEST VALLEY REPROCESSING PLANT. Quarterly Report, April 1, 1971–June 30, 1971. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 29 Jul 1971. 14p. (SRO-344-13). Dep. NTIS.

Three analyses for ^{131}I were performed on milk from the NFS farm. Thirty-seven samples were obtained from the perimeter monitoring stations and analyzed for α and β activity. The amounts of radioactivity discharged from the plant lagoons and their relation to the maximum permissible concentration in the Cattaraugus Creek are shown. Stack effluents and surveillance tests are discussed. (M.C.G.)

9011 (DOCKET-50201-100) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Change No. 15. (Division of Materials Licensing (AEC), Washington, D. C.). 20 Dec 1971. 2p. Dep. NTIS.

The date of change 15 was deferred to July 1, 1972 and interim requirements set forth. Limits are set for effluent releases to the environs. (M.C.G.)

9012 (DOCKET-50201-101) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Change No. 16. (Division of Materials Licensing (AEC), Washington, D. C.). 17 Dec 1971. 3p. Dep. NTIS.

9013 (DOCKET-50201-102) WEST VALLEY REPROCESSING PLANT. Safety Analysis High Level Waste Storage. (Nuclear Fuel Services, Inc., Rockville, Md.). 30 Dec 1971. 122p. Dep. NTIS.

Information on safety analysis of the high-level liquid waste storage facility to be constructed is presented in support of request for change in technical specifications pursuant to Section 50.59(d) of the regulations. The liquid high-level wastes are to be stored for a 5-year period prior to calcining. The environmental impact, basis of plant design, the facility and process, evaluation of system performance under abnormal conditions, and a soils and foundation investigation are discussed. (M.C.G.)

9014 (DOCKET-50201-103) WEST VALLEY REPROCESSING PLANT. Iodine Off-Gas and Acid Recovery Cell. (Nuclear Fuel Services, Inc., Rockville, Md.). 30 Dec 1971. 96p. Dep. NTIS.

Design criteria for the iodine off-gas and acid recovery cell are discussed. The dynamic earthquake analysis is summarized and drawings, graphs, and tables included. The effects of tornados were also considered. Filter and absorber design are described. Normal transient and accident conditions are discussed. (M.C.G.)

9015 (DOCKET-50268-22) MIDWEST FUEL RECOVERY PLANT. Final Safety Analysis Report, Amendment No. 21, Response to AEC Staff Questions. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 13 Dec 1971. 62p. (NEDO-10178-9). Dep. NTIS.

Information is presented in support of conversion of the construction permit into an operating license and for the final safety analysis report. Answers are given to 36 questions. (M.C.G.)

9016 (KFK-EXT-9/69-3) PRELIMINARY STUDY ON THE SHEARING OF WHOLE FUEL ELEMENT CLUSTERS OF SNR Na-2 IN KARLSRUHE REPROCESSING PLANT (WAK). Roth, B. F.; Becker, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). 1970. 23p. (In German). INIS.

As literature and experimental tests show, these are no fundamental problems to solve in the construction and building of a chopper for complete fuel elements. In building a chopper for bigger fast breeder fuel elements for the sake of experience, it seems to be sensible to assemble and build a chopper with a prototype scissor for SNR Na-2 fuel elements although the main arguments for a multiple chopper, bigger output, has not been tried. The output for a prototype chopper for closed fuel cycles of SNR Na-2 system was calculated as an example. This output depends on the fuel reprocessing and refabrication capacity. (INIS)

9017 (ORNL-4706, pp 91-9) ISOTOPE CHEMISTRY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

Research progress is reported in the following areas: fractionation of carbon isotopes: the CYANEX system; photochemistry of chlorine; ^{17}O facility: molecular spectroscopy; isotopic mass spectrometry; comparative isotopic carbon analyses of CO and CO_2; and exchange of oxygen between CO_2 (g) and V_2O_5(s). (D.H.M.)

9018 (ORNL-TM-3644) PROPOSED PROGRAM FOR HOT-CELL TESTS OF HEAD-END PROCESSES FOR LMFBR FUELS. Vaughen, V. C. A.; Goode, J. H. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 69p. Dep. NTIS.

Scouting experiments indicate that the behavior of irradiated $(U,Pu)O_2$ LMFBR fuels during chemical reprocessing is dependent on the fabrication and irradiation histories of the fuel. Several factorial experiments that may permit discovery of which variables play significant roles in the reprocessing of the fuel are outlined. (auth)

9019 (RLO-2225-T-11-2) DYNAMICS OF SOLVENT EXTRACTION SYSTEMS. PART IV. Progress Report No. 4, October 1, 1970–September 30, 1971. Babb, Albert L.; Garlid, Kermit L. (Washington Univ., Seattle. Coll. of Engineering). Oct 1971. Contract AT(45-1)-2225. 39p. Dep. NTIS.

A series of experiments was conducted to establish optimal operating conditions for the pulsed column (PC) and the controlled-cycle pulsed column (CCPC), thus making a more valid comparison possible. The system studied was methyl isobutyl ketone–acetic acid–water, with solute transfer from the ketone to water. The number of transfer units (NTU) was used as the measure of efficiency. A significant improvement in efficiencies for both PC and CCPC operations was obtained over previous experimental results, i.e., 52% and 73%, respectively. This was due to the systematic optimization procedure employed. Even more striking, however, is the increase in efficiency achieved by using a combination of pulsing and controlled cycling over that obtained with pulsing alone, 76%. Progress is also reported on mathematical modeling of column operations and noise analysis. (auth)

9020 (TID-25815) ELEMENTS OF GAS-COOLED REACTOR FUEL REPROCESSING. Wymer, R. G. (Oak Ridge National Lab., Tenn.). [1971]. 39p. Dep. NTIS.

Features of reactor fuel reprocessing, with emphasis on HTGR fuels, are discussed. The feature that sets HTGR fuel apart is the very large amount of carbon directly associated with the fertile and fissile materials. The fuel contains three types of coated particles: fissile particles containing only ^{235}U compounds, fertile particles containing only ^{232}Th compounds, and recycle particles containing both ^{233}U and ^{232}Th compounds. Burning is used to free the uranium and thorium fuel particles from the carbon after a preliminary crushing and sieving. Solvent extraction is used to separate the ^{233}U and thorium from each other and from fission products. Work on LMFBR fuel reprocessing is also reported. Safety and environmental implications are discussed. (M.C.G.)

9021 ^{95}Zr–^{95}Nb IN ENVIRONMENT. II. ADSORPTION BEHAVIOR OF ^{95}Zr–^{95}Nb ON FISHING-NET FROM SEA WATER. Ikeda, Nagao; Kimura, Kan; Kuratsune, Sadao (Tokyo Kyoiku Univ.). Radioisotopes (Tokyo); 20: No. 9, 433-7(Sep 1971). (In Japanese).

Adsorption of ^{95}Zr–^{95}Nb on 13 fishing-net samples (4 different materials) from seawater was measured at various times in order to investigate the chemical behavior of ^{95}Zr–^{95}Nb and to obtain data for estimation of the external radiation dose from ^{95}Zr–^{95}Nb released into seawater and adsorbed on fishing nets. Percent adsorption (A) increased rapidly with time (t) and began to level off at about 10 to 25 hr. The relation between A and t is given by the equation $A = k \cdot t^n$, where k is a constant and n was found to be 0.20 to 0.71. The values of A varied in the range of 10 to 80% at 50 hr equilibration with thickness (denier, D) of the thread and with material of the samples, showing a relationship $A = k' \cdot D^{-\frac{1}{4}}$,

where k is a material-dependent constant. Since $D^{-\frac{1}{2}}$ is proportional to the surface area of the sample of a unit weight, A is proportional to the surface area. A was found to vary with the type of material from which the sample was made according to the sequence, nylon > Kuremona, poly(vinyl alcohol) fiber > polyethylene > Lux, polypropylene. (auth)

9022 EXTRACTION OF SCANDIUM FROM SULFURIC ACID SOLUTIONS INTO ALKYLAMINES. Smirnov, V. F.; Nikonov, V. I.; Semenov, V. A. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 6, 1234-7(Jun 1971).

Translated from Zh. Prikl. Khim.; 44: No. 6, 1213-16(Jun 1971).

Tertiary, secondary, and primary alkylamines were tested for the solvent extraction of Sc from H_2SO_4 solutions. It was found that primary amines, such as $(C_{19}H_{37}$ to $C_{23}H_{45})NH_2$ have the best extractive properties over a wide range of acidities. The effects of solution pH and the concentrations of Sc, chlorides, nitrates, sulfates, and phosphates on the partition coefficient of Sc were also considered. The extraction of Sc into a kerosene solution of a primary alkylamine first increased with the H_2SO_4 concentration, reached a maximum at 0.5 to 0.6 M acid concentration, and then began to decrease. The extraction was diminished sharply by addition of nitrate, chloride, or phosphate ions to scandium sulfate solution. The pH also had a definite effect on the extraction. (P.C.H.)

9023 CARRIER PRECIPITATION OF TRACE ELEMENTS WITH HYDRATED MANGANESE DIOXIDE. Ujihira, Yusuke; Suzuki, Yoshimitsu (Tokyo Univ.). Radioisotopes (Tokyo): 20: No. 9, 427-32(Sep 1971).

A study is described for the carrier precipitation of μg quantities of inorganic elements with hydrated manganese dioxide from nitric acid solution using radioactive tracers. It is found that trace elements were classified in 5 groups, i.e., W(VI) and As(V) (collected completely from 0.01 to 6N), Ir(VI) and Sb(V) (collected completely from 0.01 to 1N decreasing their recovery gradually with the elevation of acidity), Fe(III) and In(III) (collected completely from 0.01 to 1N decreasing their recovery drastically with the elevation of acidity), Co(II), Cu(II), and Zn(II) (collected above pH 4.0 decreasing their recovery abruptly at lower pH, and below pH 1 no entrainment occurred) and Cs(I) (no entrainment occurred from any solution). The effects of the presence of competitive ions and complexing reagents were investigated and discussion was given to the results. (auth)

9024 CATION EXCHANGE IN THE SYNTHETIC ZEOLITE K–F. Barrer, R. M.; Munday, B. M. (Imperial Coll. of Science and Tech., London). J. Chem. Soc., A; No. 18, 2914-21(1971).

Ion exchange in the synthetic zeolite K-F was examined at 25°C and in 0.1N solutions for the ion pairs Na ⇌ Cs, Na ⇌ K, K ⇌ Cs, Na ⇌ Li, K ⇌ Li, 2Na ⇌ Ca, 2Na ⇌ Sr, 2Na ⇌ Ba, and 2K ⇌ Ba. K-F containing intracrystalline KCl [i.e., K-F(Cl)] was prepared and the isotherm for salt uptake measured. Cation exchange was examined in K-F(Cl) with different contents of KCl and it was shown that the presence of the salt within the crystals changes both isotherm contours and ion selectivities. Na-F shows high selectivity for Ca, Sr, and especially Ba, and should be useful in removing such ions from solution. Exchange isotherms were successfully interpreted by assuming two kinds of site for the exchanging ions, and in certain of the exchange reactions thermodynamic equilibrium constants were obtained. Immiscibility gaps were observed with Na-F and K-F and with Na-F and Li-F, each such gap being associated with a hysteresis loop. Confirmation of the two-phase region was obtained by x ray powder diffraction. (auth)

9025 CATION EXCHANGE REACTIONS OF ZEOLITE Na–P. Barrer, R. M.; Munday, B. M. (Imperial Coll. of Science and Tech., London). J. Chem. Soc., A: No. 18, 2909-14(1971).

Zeolite Na-P was synthesized and studied as an exchange medium at 25°C and for 0.100N solutions for the ion pairs Na ⇌ Li, Na ⇌ K, Na ⇌ Rb, Na ⇌ Cs, 2Na ⇌ Sr, and 2Na ⇌ Ba. All exchange isotherms were reversible. Among the selectivities observed two were of particular chemical interest: the preference of the crystals for Na over Li and for Ba over Na. These are sufficient, with other observed selectivities, to suggest the use of this easily synthesized zeolite to remove alkali-metal and alkaline earth-metal ions from Li salt solutions, and Ba from sodium salt solutions, in each case under neutral or alkaline conditions. The crystals also show good selectivity for Sr. Both water removal and ion exchange are associated with reversible structural changes in the rather flexible gismondite-type framework of Na-P. These changes appear to exercise a considerable influence upon isotherm contours, selectivities, thermodynamic equilibrium constants, and activity coefficients of exchange ions within the zeolite. (auth)

9026 TECHNIQUE USED TO SEPARATE ^{15}N ON COLUMNS. Axente, D. (Inst. of Atomic Physics, Cluj). Stud. Cercet. Chim.; 19: No. 4, 395-415(Apr 1971). (In Rumanian).

The literature up to the middle of 1969 on the separation of the heavy nitrogen isotope ^{15}N by isotopic exchange, chromatographic, distillation, and thermal diffusion techniques is reviewed. The reflux column method was proposed in 1936 by Urey and Aten, using the isotopic exchange reaction between ammonium nitrate and ammonia to separate ^{14}N and ^{15}N. The same principle was used by many other authors to develop separation processes for these isotopes. A subsequent proposal of Urey involving the use of ammonium carbonate instead of ammonium nitrate solution yielded a separation factor of 1020 at 25°C. The technique developed by Spindel and Taylor, based on the exchange reaction between ^{15}No and $H^{14}NO_3$, has been further improved at the laboratory scale. The ^{15}N was enriched up to 99.8%. Another method makes use of the exchange reaction between $^{14}N_2O_3$ (liquid) and ^{15}NO(gas). Chromotographic columns filled with Dowex 50 ion-exchange resin have been also used, but the chromatographic method was not found to be suitable to the preparation of large amounts of the heavy isotope. The distillation and thermal diffusion techniques present certain advantages for laboratory scale tests and analytical study for labeled compounds but they are not competitive with the isotopic exchange method. (Review article, 59 references). (TTT)

9027 GAS-PHASE CHROMATOGRAPHY OF RADIOACTIVE MATERIALS. TECHNIQUES AND APPLICATIONS. Sofronie, Elena (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Chim.; 19: No. 4, 417-36(Apr 1971). (In Rumanian).

Radioisotopic analytical techniques based on gas chromatography are reviewed; the types of radiation detectors used and the methods involved in the activity measurement of the components separated on the chromatographic column are discussed. The radiochromatographic detectors are more sensitive than those based on ionization phenomena; activities of the order of 10^{-9} Ci may be determined easily. They are used to study the most important tracers used in organic chemistry and biology, ^{14}C and T. Chromatographic analyses may be carried out continuously or intermittently; in some case combustion may be also used, involving oxidative or reductive cracking. Among the fields of application of gas chromatography, the separation of hydrogen isotopes and of radioactive rare gases, self-induced exchange reactions with tritium, isotopic exchange reaction with iodine, separation on purification of labeled molecules, radiolysis of labeled compounds, and various specific organic and biochemical research applications are described. (TTT)

9028 APPLICATION OF NITRIDE-FORMING REACTIONS TO REPROCESSING OF SPENT NUCLEAR FUELS. Anderson, R. N.; Parlee, N. A. D.; Gallagher, J. M. (Stanford Univ., Calif.). Nucl. Technol.; 13: No. 1, 29-35(Jan 1972).

The thermodynamics and kinetics of nitrogen–nitride reactions in liquid uranium–tin alloys have been investigated experimentally. In the presence of dissolved metal impurities in the alloys, the nitrogen was found to react with the uranium to form UN which can, under proper conditions, be precipitated as a pure phase from the melt, leaving impurities behind. Thus, the concept of nitride precipitation offers a possible metallurgical separation method applicable to the reprocessing of spent fast reactor fuels. On the basis of the laboratory studies for uranium and the extrapolated behavior for plutonium, it appears achievable to attain 99% uranium recovery and 98% plutonium recovery, with decontamination factors of 10^6. (auth)

9029 CHEMICAL SEPARATIONS OF ELEMENTS PRODUCED BY INTERACTION OF HEAVY IONS AND α PARTICLES WITH Ag AND Ta TARGETS. Fleury, Alain; Hubert, Francoise (Univ., Bordeaux). Bull. Soc. Chim. Fr.; No. 8, 3090-1(Aug 1971). (In French).

The separations of In and Cd from Ag targets and W and Re from Ta targets were carried out using precipitation and solvent extraction methods. The element studied was obtained in a weighable form and the separation yield determined. (France)

9030 IMPROVED PROCESS FOR PREPARING HEAVY WATER BY ISOTOPIC EXCHANGE (MONOTHERMIC TYPE) BETWEEN AMMONIUM GAS AND SYNTHESIS GASES. Lesur, Pierre; Viratelle, Jean (to Societe Chimique des Charbonnages. Commissariat a l'Energie Atomique. l'Air Liquide. l'Exploitation des Procedes Georges Claude. Compagnie de Construction Mecanique, Procedes Sulzer). French Patent 2,056,050. 19 Apr 1971. Filed 25 Aug 1969. (In French).

A process for preparing heavy water is described. The process involves isotopic exchange (monothermic type) between the synthesis gas and the ammonia gas, the synthesis gas circulates

countercurrent to the liquid ammonia in the isotope extraction tower, it is fed into a synthesizing unit, where a quantity of the synthesis gas, sufficient to ensure the necessary reflux of the liquid ammonia in the isotope extraction tower, is transformed into ammonia gas. (France)

9031 SOLVENT EXTRACTION OF 4f AND 5f SERIES ELEMENTS FROM ALKALINE MOLTEN NITRATES. Foos, Jacques; Guillaumont, Robert (Paris Univ., Orsay, France). Bull. Soc. Chim. Fr.; No. 9, 3129-35(Sep 1971). (In French).

The behavior of 4f and 5f elements (such as Sm, Eu, Gd, Tb, Dy and Am, Cm, Bk, Cf) at 150°C between a $LiNO_3-KNO_3$ eutectic ($\frac{1}{2}$ wt) and tributyl phosphate (TBP) or triphenylphosphine oxide (TPO) solutions in a polyphenyl eutectic was measured as a function of the concentration of these reagents in the organic phase. The solvation constants of the extracted nitrates were determined for all these elements except Tb and Bk, which are not extracted by these electron donor reagents. This is probably due to the formation of Tb(IV) and Bk(IV) oxides in the oxidizing saline phase. (France)

9032 SEPARATION OF URANIUM IN SEAWATER. Takai, Nobuharu; Yamabe, Takeo (Tokyo Univ.). Mizu Shori Gijutsu; 12: No. 4, 3-8(Apr 1971). (In Japanese).

Uranium is present in seawater as $\{UO_2(CO_3)_3\}^{4-}$. Methods of separation are coprecipitation, adsorption, ion flotation, solvent extraction, and biological. In the coprecipitation method, uranium is precipitated with $Fe(OH)_3$, $Al(OH)_3$, and $Ti(OH)_4$. However, the precipitation rate of the hydroxides is generally low. In the adsorption method, titanates, resorcinol, and arsonic acid resin are useful as absorbents. Basic zinc carbonate, lead sulfide, and active carbon also show good adsorptivity. Estimated cost of uranium collected by this method is about 30 to 35 million yen per ton. In the flotation method, surface-active agents are added to seawater and air is blown in to form bubbles. Phosphoric acid esters show excellent bubbling effect in seawater. For the solvent extraction method, kerosene and dibutyl phosphate are possible solvents. Few studies have been made on concentration of uranium in seawater by microorganisms. (Japan)

9033 CHEMISTRY OF THE ELECTROMAGNETICALLY SEPARATED STABLE ISOTOPES. Isotop. Radiat. Technol.; 9: No. 2, 133-49(Winter 1971-1972).

In this fifth article of a series reviewing the chemical purification of stable isotopes enriched electromagnetically at Oak Ridge National Laboratory, the purification methods for isotopes of Cd, Cl, In, Pd, K, Ru, Ta, and Ti are given. (auth)

9034 URANIUM, SUCCESSIVE TREATMENT. Grenon, M. Sci. Progr. Decouverte; No. 3436, 16-26(Aug 1971). (In French).

The preparation and treatment of spent fuel in nuclear power stations involve a series of operations linked with economic and political factors. The particular characteristics of the different operations are described. The needs, which must be satisfied by 1980, require the mutual effort of the interested parties. (France)

9035 IMPROVED SYSTEM FOR PRODUCING DEUTERIUM. Trichet, Jean; Simonet, Guy; Guellaff, Jean-Pierre. (to L'Air Liquide). French Patent 2,055,852. 19 Apr 1971. Filed 1 Aug 1969. (In French).

An improved system for producing deuterium from hydrogen is described. The hydrogen is produced by oxidation of a metallic mass by water vapor; the metallic mass is then regenerated by reduction using at least a part of the recollected hydrogen and possibly a hydrocarbon such as methane. (France)

9036 PROCESS FOR THE RE-ENRICHMENT OF HYDROGEN DEPLETED IN DEUTERIUM IN A PLANT FOR THE PRODUCTION OF DEUTERATED PRODUCTS, PARTICULARLY HEAVY WATER. Botter, Fernande; Dirian, Gregoire; Pauly, Jean; Roth, Etienne (to Commissariat a l'Energie Atomique). French Patent 2,041,395. 18 Jan 1971. Filed 23 Apr 1969. (In French).

A base, soluble in water and with a vapor pressure greater than that of water, is used as a catalyst in the isotopic exchange between gaseous hydrogen, depleted in deuterium, and ordinary water. The catalyst is then recovered from the liquid phase and the cycle recommences. (France)

9037 METHOD OF EXTRACTING URANIUM FROM ITS ORES. Gautier, Rene (to Ugine-Kuhlmann). French Patent 2,063,581. 14 Jun 1971. Filed 22 Oct 1969. (In French).

In this process for extracting U from its ores, the ore is reacted with ammonium bisulfate. An aqueous sludge is formed from which the dissolved U compounds are extracted in liquid form. The ammonium bisulfate contained in the ammonium sulfate formed during the reaction, or formed by the action of ammonia gas with the other products produced during the reaction and the dissolution in the aqueous medium, is reused. (France)

9038 PUTTING INTO OPERATION OF A URANIUM ORE CONCENTRATING PLANT IN THE REPUBLIC OF NIGERIA. Renaud, J. (Ugine Kuhlmann, Paris). Energ. Nucl. (Paris); 13: No. 4, 261-4(Jul 1971). (In French).

The characteristics of the Arlit ore are briefly described. The different processes used in the concentration procedure are examined: mechanical treatment, dissolution of the uranium, washing of the pulp, recovery of the uranium from the clear uraniferous liquids, and precipitation of the concentrate. (France)

9039 PROCESS FOR TREATING URANIFEROUS ORE. Lafforgue, Paul (to Commissariat a l'Energie Atomique). French Patent 2,050,549. 22 Mar 1971. Filed 17 Jun 1969. (In French).

A process for treating uraniferous ore by alkaline carbonate leaching in an oxidizing atmosphere is described. The method is particularly useful when part of the uranium present is tetravalent and possibly in the presence of reducing substances. A characteristic of the process is that the reaction takes place in the presence of Fe, Zn, Ni, Co, Pb, or Mn compounds. (France)

9040 STUDY BY HYBRID SIMULATION OF THE OPERATIONAL SAFETY OF A UPu EXTRACTION BATTERY AND ITS CONTROL. Rouyer, M (CEN, Fontenay-aux-Roses, France); Chazal, G. Bull. Instrum. Nucl.; No. 43, 5-14(Mar 1971). (In French).

A battery of mixer-settlers consisting of an eight-stage extraction section, and a six-stage washing section, operating according to the countercurrent principle, was simulated. The static safety associated with the fissile material concentrations at all points in the extraction apparatus, and the dynamic safety depending on fluctuations in the extraction and dissolution operations or temperature variations were studied. (France)

9041 CHEMICAL PROCESSING OF CYCLOTRON PRODUCED ^{67}Ga. Brown, L. C. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop.; 22: No. 11, 710-13(Nov 1971).

In order to improve the ^{67}Ga product chemical purity and to reduce the chemical processing time, a new chemical separation and purification procedure based on previously reported work was developed and tested. The method is applicable to both zinc and electrodeposited zinc on copper targets, and yields a product of suitable purity for subsequent preparation of a radiopharmaceutical for human use. This new procedure employs the extraction of Ga(III) from 7M HCl with isopropyl ether and can be easily adapted to isotopically enriched targets with minimal changes. The use of isopropyl ether, a highly specific extractant for Ga(III) from HCl solution, rather than hexone, made it possible to omit the anion exchange chromatography procedure employed earlier to increase the decontamination from zinc. As a result, the total processing time was reduced from approximately 12 hr to ~2 hr. (UK)

9042 CATION-EXCHANGE SEPARATION OF URANIUM FROM OTHER ELEMENTS IN TETRAHYDROFURAN–NITRIC ACID MEDIA CONTAINING TRIOCTYLPHOSPHINE OXIDE. Khater, M. M.; Korkisch, J. (Univ., Vienna). Talanta; 18: No. 10, 1001-4(Oct 1971).

The batch distribution coefficients of Cu(II), Zn, Cd, Fe(III), Hg(II), Mg, Co(II), Ni, Pb, Ca, and Bi were determined on the strongly acidic cation exchange resin Dowex 50 × 8 in 0.1 M trioctylphosphine oxide in tetrahydrofuran –5% 12 M nitric acid. In this mixture all these metal ions, except Bi, have high K_d-values and can be separated quantitatively from uranium which has a distribution coefficient of 0.1. Mixtures of U with Cu, Ni, Co, Cd, or Fe were analyzed to test the applicability of such separations. Different titrimetric and spectrophotometric methods were used to determine the elements subsequent to their separation from uranium on ion exchange columns. The results show that accurate and effective separations can be achieved. (auth)

9043 METHOD FOR INCINERATING ORGANIC PHOSPHORATED LIQUIDS. Lefillatre, Guy; Rodi, Lucienne (to Commissariat a l'Energie Atomique). French Patent 2,061,935. 1 Jun 1971. Filed 3 Oct 1969. (In French).

The TBP used for extraction of Pu in the reprocessing of irradiated fuels must be incinerated after it has been used in a number of cycles. An incineration procedure was developed, which involves the combustion of the organic phosphorated liquids produced and the neutralization of the phosphoric acid liberated during the combustion. A metallic soap is added to the liquid to be treated, this soap being a calcium salt of a fatty acid soluble in

the liquid. The mixture obtained is incinerated and the combustion gas produced is filtered in order to retain the calcium phosphate that may be present. (France)

9044 PROCESS FOR INCORPORATING FISSION PRODUCTS IN A VITRIFIED MASS. Bonniaud, Roger; Gougeard, Jean-Marie; Moulin, Jean; Reboux, Jean; Sombret, Claude. (to Commissariat a l'Energie Atomique). French Patent 2,054,464. 23 Apr 1971. Filed 7 Jul 1969. (In French).

A process for incorporating fission products in a vitrified mass is described. A crucible made of an electrically insulating refractory material is progressively, and if necessary continuously, fed with a mixture of calcined fission products and adjuvants, forming a glass, which in the molten state has a resistivity of less than 100 ohms-cm^2/cm. The vitrified mass is melted by direct induction using h–f electric currents (10 kHz to 10 MHz). A plug of glass is periodically melted at the outlet at the bottom of the crucible using induction currents; this allows the glass to flow into a storage container. (France)

9045 STUDY ON THE ANION EXCHANGE BEHAVIOUR AND SEPARATION OF PROTACTINIUM, ZIRCONIUM, AND NIOBIUM IN HAc–HNO_3–HF MIXTURES. Kim, J. I.; Lagally, H.; Born, H.-J. (Technische Univ., Munich). J. Inorg. Nucl. Chem.; 33: No. 10, 3547-55(Oct 1971).

Adsorption characteristics of Pa, Zr, and Nb on the anion exchanger Dowex 1 × 8 are studied in a mixed system of HAc–HNO_3–HF. The adsorption of these elements is continuously enhanced by increasing the concentration of acetic acid and the distribution coefficients are higher in the mixed system than in HNO_3 or HNO_3–HF without HAc. Under conditions where all three elements give stable solutions, the adsorption rate appears the highest for Pa, intermediate for Zr and lowest for Nb. These data provide the basis for an effective separation, with one column operation it is also possible to separate Pa from its daughter products as well as Zr and Nb, present as impurities. (auth)

9046 SOLVENT EXTRACTION OF NEPTUNIUM(V) AND (VI) SPECIES: LIMITATIONS IN THE USE OF AMINE EXTRACTION IN THE STUDY OF COMPLEX FORMATION. Bullock, J. I.; Tuck, D. G. (Univ. of Nottingham, Eng.). J. Inorg. Nucl. Chem.; 33: No. 11, 3891-3904(Nov 1971).

Nitrato, chloro, oxalato and sulphato complexes of neptunium(VI), and oxalato and sulphato complexes of neptunium(V), can be extracted from aqueous acid solution by methyldioctylamine in chloroform. No extraction of either neptunium(V) or (VI) could be detected from aqueous solutions containing acetic, formic, citric or perchloric acids. These results are discussed in terms of the known complexing behavior of these oxidation states of neptunium. The application of the amine extraction technique in the study of complex formation in aqueous solution is discussed; unambiguous identification of anionic complexes is only possible when the relevant stability constants are large. (auth)

9047 SODIUM PURIFICATION PROCESS. De Vries, Paul F.; Scarborough, James M. (to United States Atomic Energy Commission). U. S. Patent 3,600,155. 17 Aug 1971. Filed 16 Sep 1969.

A process for the purification of sodium wherein sodium is heated or cooled to a temperature just above its melting point such that impurities, such as sodium oxide, which are very nearly insoluble in sodium at this temperature, rise to the surface of the pool of sodium, whereafter the sodium below the surface, which is essentially free of impurities, is removed. This process is applicable for producing purified sodium for general use, but is particularly effective in a continuous operation as required in circulating systems such as nuclear reactors, heat exchangers, research loops, etc. where continuous removal of impurities is required. (auth)

9048 STABILITY CONSTANTS OF THE COMPLEXES FORMED BY Am(III), Cm(III), AND Cf(III) WITH DIETHYLENETRIAMINEPENTAACETIC ACID. Brandau, E. (Kernforschungszentrum, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett.; 7: No. 12, 1177-81(Dec 1971). (In German).

A fresh determination of the stability constants for the complexes formed by Am(III), Cm(III), and Cf(III) with diethylenetriaminepentaacetic acid (H_5DTPA) is reported. The results show that the stability of the actinide complexes with H_5DTPA increases with increasing atomic number, as with complexes formed with other polyamino-acids. This tendency becomes more marked with decreasing ionic radius. The calculated separation factors indicate that it is unlikely that an Am/Cm separation can be effected but that good separations can be obtained between Am and Cf or Cm and Cf at pH = 2. (UK)

9049 PLUTONIUM SEPARATION FROM URANIUM. Wenz, Donald A. (to United States Atomic Energy Commission). U. S. Patent 3,607,145. 21 Sep 1971. Filed 6 Jan 1969.

Plutonium dioxide is more soluble in molten magnesium chloride than is uranium dioxide. Separation of plutonium from a mixture of plutonium dioxide and uranium oxides is accomplished by dissolving the plutonium dioxide from the mixture with magnesium chloride and separating the undissolved uranium oxides. (auth)

9050 CHEMICAL EXCHANGE METHOD OF CONCENTRATING CARBON ISOTOPES. Brown, Lloyd L. (to United States Atomic Energy Commission). U. S. Patent 3,607,010. 21 Sep 1971. Filed 17 Feb 1969.

A method of altering the relative concentrations of ^{12}C and ^{13}C in carbon-containing compounds comprises contacting a liquid organic phase containing a cyanohydrin with an aqueous phase containing a cyanide, thereby enriching the cyanohydrin in ^{13}C and the cyanide in ^{12}C. (auth)

9051 EXTRACTION OF ACIDS AND NEPTUNIUM FROM ALCOHOLIC AND ACETONIC SOLUTIONS. Allan, A.; Sanad, W.; Shabana, R.; Haggag, A. (Atomic Energy Establishment, Cairo). Microchem. J.; 16: No. 4, 515-25(Dec 1971).

The extraction of nitric acid with tridodecylamine (TDA) was studied as a function of methanol, ethanol, isopropanol, and acetone concentration in the aqueous phase. Extraction increases in the order: methanol < ethanol < isopropanol < acetone. The extraction of nitric acid by TDA is affected by these additives more than the extraction of hydrochloric acid. Neptunium extraction from HNO_3 and HCl solutions by TDA and TBP was studied, also as a function of the concentration of the above additives. Extraction of neptunium from nitric acid solutions is slightly influenced by additives, while the effect is considerable in case of extraction from hydrochloric acid solutions. (auth)

9052 EXCHANGE CAPACITY OF AMMONIUM PHOSPHOMOLYBDATE FOR CESIUM BY BATCH TECHNIQUE. Krishnamoorthy, T. M.; Doshi, G. R.; Sastry, V. N. (Bhabha Atomic Research Centre, Bombay). Curr. Sci. (India); 40: No. 20, 542-4(20 Oct 1971).

The carrying capacity of preformed microcrystalline ammonium molybdophosphate (AMP) in a single step for cesium at various stable cesium carrier levels was investigated. It was concluded that 100 mg AMP is sufficient to carry ^{137}Cs quantitatively from 1 liter of seawater; with 200 AMP, 10 mg Cs can be quantitatively carried from 1 liter of seawater; and NH_4^+ concentrations higher than 0.33 g/l interfere with the carrying of ^{137}Cs when 200 mg AMP is used per liter of seawater. (D.H.M.)

9053 EXTRACTION OF PICRIC ACID, ALKALI METAL PICRATES, AND TRACES OF CESIUM FROM WATER INTO NITROBENZENE. Rais, J.; Selucky, P. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun.; 36: No. 8, 2766-74(Aug 1971).

Extraction of picric acid and of alkali metal picrates into nitrobenzene is studied. The term of limiting distribution ratio is introduced, describing the distribution of microamounts of cation M^+ between the aqueous and organic phases in the presence of macroamounts of N^+A^- salt and under the assumption of total dissociation in both phases. The corresponding extraction constants are given and practical applications to extraction of microamounts of ^{137}Cs are discussed. (auth)

9054 COLLECTION OF URANIUM IN SEA-WATER. X. CHEMICAL STATE OF URANIUM IN SEA-WATER AND ADSORPTION MECHANISM OF TITANIC ACID. Ogata, Noboru (Japan Monopoly Corp., Odawara); Inoue, Nobuko; Kakihana, Hidetake. Nippon Genshiryoku Gakkaishi; 13: No. 10, 560-5(Oct 1971). (In Japanese).

The chemical state of uranium in seawater was sought from stability constants. It was estimated that uranium in seawater existed as U(VI) and that the distribution of the chemical species in standard seawater was: $UO_2(CO_3)_3^{4-}$ 97.9%, $UO_2(OH)_3^-$ 1.73%, and $UO_2(CO_3)_2^{2-}$ 0.4%. The cation-exchange ability of titanic acid was demonstrated from the fact that the pH value of NaCl solution shifted toward the acidic side by the addition of titanic acid. But, despite this cation-exchange ability, it is thought that the form in which titanic acid adsorbed uranium is probably $UO_2(CO_3)_3^{4-}$, because it was found to adsorb HCO_3^- in quantities proportional to uranium. From the results of the present and previous studies, it is presumed that uranium is adsorbed by the coordinate bond. (auth)

9055 SOLVENT EXTRACTION OF SOME DIPROTIC NITROAROMATIC ACIDS AND OF THEIR COMPLEXES WITH

SOME ACTINIDES. II. EXTRACTION OF URANYL 3-NITRO-p-CRESOL-5-SULPHONATE COMPLEXES WITH TRIBUTYL-PHOSPHATE. Beran, M. (Nuclear Research Inst., Rez, Czech.). J. Inorg. Nucl. Chem.; 33: No. 11, 3885-90(Nov 1971).

Extraction of uranyl complexes from the 1M(H,Na)Cl solution containing 3-nitro-p-cresol-5-sulphonic acid (H_2A) with n-dodecane solution of TBP at 25°C was investigated. The prevailing extractable species seems to be $UO_2A \cdot 2TBP$, the two-phase stability constant of which was calculated to be $(3.57 \pm 0.37) \times 10^6$. The stability constant of the main aqueous species, UO_2A, is $(7.89 \pm 2.35) \times 10^5$. The role of chloride complexes in the extraction equilibrium was evaluated and their stability constants calculated. (auth)

9056 PLUTONIUM AND NEPTUNIUM EXTRACTION PROCESS. Schulz, Wallace W. (to United States Atomic Energy Commission). U. S. Patent 3,595,629. 27 Jul 1971. Filed 14 Aug 1969.

A process is described for separating plutonium and neptunium values from aqueous acid waste solutions containing these and other values by adding hydrazine to the aqueous waste solution to reduce selectively the neptunium to the tetravalent state and contacting the solution with a water-immiscible organic solution of dibutyl butyl phosphonate to extract the tetravalent neptunium and plutonium values plus zirconium, cerium, and ruthenium values present. After separating the organic phase from the aqueous waste solution, the coextracted zirconium, cerium, and ruthenium values are scrubbed from the organic phase before stripping the neptunium and plutonium values with an aqueous oxalic acid stripping solution. (auth)

9057 STUDIES ON SOLVENT EXTRACTION OF METAL ION-DINITROOXINE-RHODAMINE B. Toei, Kyoji; Nakato, Kazumasa (Okayama Univ., Japan). Nippon Kagaku Zasshi; 92: No. 8, 731-4(Aug 1971). (In Japanese).

Neodymium(III) in an aqueous solution reacts with 5,7-dinitrooxine (DNO) to form a large complex anion, $[Nd(DNO)_4]^-$. The anion forms an ion-pairing associate with a large cation, Rhodamine B, and it is extractable into benzene. Rhodamine B in benzene has an absorption maximum at 553 nm. The optical density is proportional to the amount of neodymium(III) in the aqueous solution. The apparent molar absorption coefficient is 9.27×10^4. The composition ratio of the associate, Nd^{3+}: DNO: Rhod. B, is determined to be 1:4:1 by a molar ratio method. The same procedure is applied to other metal ions. Ions extractable at pH 3 to 8 are Co(II), Ni(II), Mn(II), Fe(II), Fe(III) (nonfluorescence), and Zn(II), Cd(II), Hg(II), Y(III), In(III), Pb(II), La(III), Er(III), and Th(IV) (fluorescence). The composition of these extracts is $[M^{n+}(DNO)_{n+1}]^-[Rhod.\ B]^+$. (auth)

9058 RADIOLYSIS OF HANFORD B PLANT HDEHP EXTRACTANT. Schulz, Wallace W. (Atlantic Richfield Hanford Co., Richland, Wash.). Nucl. Technol.; 13: No. 2, 159-67(Feb 1972).

Irradiation (^{60}Co source) tests were performed to determine effects of radiolysis of HDEHP bis(2-ethylhexyl)phosphoric acid solvents. (An HDEHP–TBP–kerosene extractant is used in the Hanford B Plant to extract ^{90}Sr from Purex process high-level waste.) Irradiation to 230 to 350 Wh/liter destroys only small (~6%) amounts of HDEHP; the principal radiolytic effect is a two- to threefold decrease in strontium extraction capacity. This effect is ascribed to polymerization of HDEHP with itself and/or with H_2MEHP [mono(2-ethylhexyl)phosphoric acid], a primary radiolysis product. Dilute NaOH and Na_2CO_3 solutions wash H_2MEHP from irradiated HDEHP extractants; however, only with solvents irradiated in the absence of any aqueous phase do such washes improve strontium extraction properties. Addition of unirradiated HDEHP to irradiated HDEHP solvents increases their ability to extract strontium; this simple procedure is used to maintain the strontium extraction capacity of the B Plant solvent at a suitable level. Performance and properties of plant solvent are in general agreement with those anticipated from ^{60}Co irradiation tests. (auth)

9059 EFFECT OF pH ON THE DISSOLUTION OF PITCHBLENDE UNDER NORMAL CONDITIONS. Zhil'tsova, I. G.; Karpova, L. N. At. Energ. (USSR); 31: No. 1, 58-9(Jul 1971). (In Russian).

The experimental dissolution of pitchblende was conducted at various pH levels, at room temperature and atmospheric pressure, and the effects of the presence of Mo and Fe sulfides were also studied. Pitchblende samples were found to vary greatly in physical and optical properties, e.g., the specific weight varied between 4.5 and 7.1. The variety of samples resulted in a family of curves for each parameter studied. The presence of Mo and Fe sulfides apparently increased the rates of oxidation and dissolution of the pitchblende. (K.S.W.)

9060 THERMODYNAMICS OF NITRIDE REACTIONS IN MOLTEN URANIUM–TIN ALLOYS AND APPLICATIONS TO NUCLEAR FUEL REPROCESSING. Anderson, Robert Neil. Stanford, Calif.; Stanford Univ. (1970). 406p. University Microfilms Order No. 71-19,789.

Thesis.

The nitride-forming reactions of liquid U–Sn alloys (2 to 18% U) were studied over the temperature range 637 to 1610°C using a Sieverts-type apparatus. The results of this study show that, depending primarily on the melt temperature, either of two distinct reactions may occur: $U + \frac{1}{2}N_2(g) = UN(s)$ (for temperatures above ~1500°C) and $2U + 3/2N_2(g) = U_2N_3(s)$ (for temperatures below ~1500°C). The first reaction is readily reversible, whereas the latter is reversible with hysteresis. Equilibrium constants and the effect of temperature on these constants were determined for these two reactions. The interaction coefficient and activity of the uranium dissolved in liquid tin were determined for alloys containing up to 18% uranium by weight. The uranium activity in liquid tin was found to be sufficiently low so that graphite crucibles could be used without forming uranium carbide. The U–Sn alloy was unusual and the nitride formation differed from similar types of systems in two major respects: the solubility of nitrogen in the liquid metal phase was extremely small, and uranium nitride, being more dense than the liquid alloy, would sink. This type of nitride-forming reaction may offer an attractive method of producing actinide nitrides for nuclear reactor fuels and suggests possible methods of reprocessing spent nuclear fuels. It was determined, with the aid of an empirical method developed to estimate the standard free energy of nitride formation from pure metals, that many fission product elements would remain dissolved in the liquid tin. The differences in concentration, with resultant differences in activity, for a typical low burnup uranium fuel would allow considerable uranium nitride to be precipitated before its activity was reduced to the point where coprecipitation and resultant contamination would occur. Many of the fission product nitrides that formed would float, whereas the uranium nitride would sink. Decomposition of the UN in fresh tin and distilling off the tin under vacuum produced pure uranium metal. (Diss. Abstr. Int., B)

9061 ANION-EXCHANGE OF THORIUM ON DEAE-CELLULOSE IN METHANOL–NITRIC ACID MEDIA. Kuroda, Rokuro (Univ. of Chiba, Japan); Ono, Toshio; Ishida, Koji. Jap. Anal.; 20: No. 9, 1142-5(Sep 1971). (In Japanese).

Many metals do not favor the DEAE-cellulose to any great extent from aqueous nitric acid solutions. However, thorium exhibits an enhanced adsorption on DEAE from mixed methanol–nitric acid media. This behavior of thorium on DEAE allows the development of a highly selective method for the separation of thorium. Even barium, bismuth(III), the rare earths, and lead(II), which are adsorbed tightly on a strongly basic anion exchange resin Dowex 1 from methanolic acid media, do not show any marked adsorption on DEAE. Thus, as little as 100 μg thorium can be separated quantitatively from a hundred times as much other metal ions on a small column containing 1 g DEAE in methanol–nitric acid (20:1, v/v) media. The concentration of nitric acid may be allowed to vary from 1 to 13 M. Increasing amounts of DEAE should be used with increasing amounts of thorium to be loaded on the column. Quantitative separations of thorium from thirty metals were reported. (auth)

9062 APPLICATION OF THE COMPUTER SOLUTION OF PROBLEMS IN THE DYNAMICS OF ION-EXCHANGE CHROMATOGRAPHY TO THE TECHNOLOGY OF RARE ELEMENTS. IV. DYNAMICS OF THE EXCHANGE OF TWO LANTHANIDE CATIONS IN THE PRESENCE OF ETHYLENEDIAMINETETRA-ACETIC ACID. Legenchenko, I. A. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 3, 350-3(Mar 1971).

Translated from Zh. Fiz. Khim.; 45: No. 3, 636-40(Mar 1971).

A method is proposed for the calculation of the mass transfer coefficients for a two-component system based on a computer analysis of output curves. The method was used to analyze the experimental data for the exchange of two lanthanide cations in the presence of H_4EDTA. The kinetic coefficients and the number of elementary layers in the column under different conditions were calculated. The theoretical output curves calculated from these data give a satisfactory description of the exchange process. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 9188, 9236, 9238, 9239, 9259, 9286–9288, and 9290–9292.

9063 (NVO–48(Rev.1)) REVIEWS TO INSURE SAFETY OF NUCLEAR OPERATIONS. (Nevada Operations Office (AEC), Las Vegas). Aug 1971. 16p. Dep. NTIS.

A description is given of the series of reviews which are made prior to any nuclear detonation to ensure that the event is conducted safely and within the constraints of the Limited Test Ban Treaty. The disciplines involved in performing nuclear explosion safety evaluations include: health physics, biology; meteorology; seismology; hydrology; geology; ecology; structural mechanics; and rock mechanics. Methods for predicting, measuring, and evaluating data on nuclear explosion effects are discussed. Information is presented on: the name, responsibility, membership, and activities of safety organizations for USAEC nuclear operations; AEC organization chart for effects management and review; and listing of the personnel involved with specific segments of the NVOO Effects Evaluation Program. (L.C.L.)

9064 (SC-RR-69-334) FREE-FIELD AND SURFACE MOTION FROM A NUCLEAR EXPLOSION IN ALLUVIUM: MERLIN EVENT. Perret, William R. (Sandia Labs., Albuquerque, N. Mex.). Nov 1971. 172p. Dep. NTIS.

Free-field and surface motion measurements were made in conjunction with the Merlin event in February 1965. These observations were planned to aid in understanding the mechanisms of cavity collapse and surface subsidence following contained nuclear explosions in desert alluvium. Instruments in two vertical arrays offset 50 and 150 feet laterally from the Merlin emplacement boring were designed to respond to initial motion and to ride downward with the subsiding earth above the explosion. In addition, two horizontal gage arrays were installed at shot depth and at the ground surface between the emplacement boring and a boring 2500 feet to the north. Time-of-arrival data for all stations indicate propagation of the motion at a velocity of about 5030 ft/sec in the shot-level alluvium and at a velocity of 3640 ft/sec through the uppermost 300 feet of the section. Remote shot-level data indicate refraction at a depth of 190 feet below shot level in a rock of 6920 ft/sec velocity, probably tuff. There is evidence of an elastic precursor wave in the vertical array data. It ranges from about 20 bars to 6 bars where the maximum stress ranges from 80 to 12 bars. Energy associated with transient motion at the shot-level stations indicates that a mean of 1.6×10^{17} ergs or about 0.04% of the 4.2×10^{20} ergs released by the explosion was propagated beyond 700 feet and represent the seismic source energy. The seismic source is further defined by a reduced displacement potential having a maximum value of 5×10^4 ft^3 or 1440 m^3 and a residual of about 1.8×10^4 ft^3 or 500 m^3. Application of two methods for estimating depths of spall partings to the Merlin data indicates that analysis of reflected tensile stress does not yield positive results in a dry desert alluvium environment. Ray-tracing analysis of impact acceleration signals from vertical array data indicates four possible partings at depths of about 25 to 30 feet, 70 feet, 150 feet, and 255 feet. Cavity collapse data from the vertical array of instruments yielded only data relevant to initiation of subsidence because of circuit failure shortly thereafter. These data indicate that the station 500 feet deep began to drop 1155.24 seconds after detonation and the surface started downward about 1.49 seconds later. Surface motion records yield a vertical displacement profile immediately after subsidence which agrees closely with the aerial survey profile recorded about 70 minutes later, except at the 50-foot station where the latter indicates a further subsidence of about 8 feet. (auth)

9065 (SC-RR-710864) CRATERS IN WHITE SANDS ALLUVIUM FROM SURFACE-BURST HEMISPHERES. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Dec 1971. 23p. Dep. NTIS.

Craters in White Sands alluvium from surface-burst hemispheres are reported and compared with craters from similar charges in other media. Crater dimensions are larger (volume approximately 1.7 times larger) than for shots in rock and smaller than for shots in silt (volume approximately 0.4 times volume in silt). Scaling with charge weight is reasonably consistent for the three media. (auth)

9066 DISCUSSION OF PAPER BY T. R. BUTKOVICH, INFLUENCE OF WATER IN ROCKS ON EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Sun, James M. S. J. Geophys. Res.; 76: No. 35, 8604-7(10 Dec 1971).

The water-boost model recently used by Butkovich (J. Geophys. Res., 76, 1993-2011, 1971) seems to be designed as only an approximate method of calculation, without consideration of many physical aspects of the earthy materials. It is argued that the effects of nuclear explosions upon water-bearing earthy materials can be determined and studied more realistically by using direct and straightforward experimental methods. A reply by Butkovich is included. (W.D.M.)

9067 EXAMINATION OF CRATERING FORMULAS AND SCALING METHODS. White, John W. (Univ. of California, Livermore). J. Geophys. Res.; 76: No. 35, 8599-8603(10 Dec 1971).

Techniques that have been used for understanding the cratering process and predicting crater size are reviewed. The cratering process is shown to be unscalable, although many investigators have considered it to be scalable. Results of some specific work are presented, and their distinguishing features are discussed. (auth)

9068 PHYSICAL ASPECTS OF NUCLEAR EXPLOSIVE TECHNIQUES. Langer, M. Phys. Unserer Zeit; 2: No. 3, 66-73(1971). (In German).

On the basis of Project Plowshare data a general review of the following main topics is given: energy of nuclear explosions, calculation of cavity radius and chimney height, crater formation, radioactivity, seismic wave propagation, and possible applicability of nuclear explosive techniques. (INIS)

9069 PROGRESS IN HIGH TEMPERATURE PHYSICS AND CHEMISTRY. VOLUME 4. Rouse, Carl A. (ed.). Elmsford, N. Y.; Pergamon Publishing Company (1971). 203p. $19.50.

Four papers related to high-temperature physics and chemistry are included in this volume. A separate abstract was prepared for each of two papers. Two papers appeared previously in NSA as 25: 55685 and 25: 55751. (L.C.L.)

For abstracts of individual papers see: 9070 and 10131.

9070 PEACEFUL NUCLEAR EXPLOSIONS. Johnson, Gerald W. (Gulf General Atomic Inc., San Diego, Calif.). Progr. High Temp. Phys. Chem.; 4: 85-97(1971).

Underground nuclear explosions have been considered for applications such as large scale excavation, natural gas stimulation and storage, and recovery of minerals because nuclear explosives are compact and cheap and because Plowshare experience has demonstrated the possibility of ensuring public health and safety in the use of underground nuclear explosions. Plowshare experiments are reviewed with data on costs, cratering results, fallout characteristics and distribution, and general safety. The problems which remain to be solved before underground nuclear explosions can be used commercially are discussed. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 9224, 9547, 9669, 9692, 9738, and 9920.

9071 (AECL–3990) AECL RESEARCH IN ENGINEERING, SUMMER 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1971. 16p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

Aspects of engineering research at Atomic Energy of Canada Limited are reviewed. The topics covered are: engineering the Slowpoke reactor; heavy water production using amine-hydrogen isotopic exchange; a new technique for frequency response measurements; up-rating the U–1 loop; and a model for making quantitative estimates of increase in reliability during a development program. (E.M.T.) (Canada)

9072 (AI-AEC-Memo–12869) SODIUM-TO-AIR COOLING SYSTEM. Newburn, F. A. (Atomics International, Canoga Park, Calif.). 27 Jun 1969. 39p. Dep. NTIS.

A summary is presented of pertinent information on liquid metal-to-air-cooled heat exchangers which will be applicable to the design of the heat pumps required for cooling the main driver and closed loop systems of the proposed Fast Flux Test Facility. It includes present design status, operation history, problem areas and solutions, failures and causes, and past and present day development needs of this type heat exchanger. (auth)

9073 (GAMD-10457) GCA TECHNOLOGY COURSE ON THE FORT ST. VRAIN STEAM GENERATORS. Schuetzenduebel, W. G. (Gulf General Atomic Co., San Diego, Calif.). 15 Jan 1971. Contract AT(04-3)-633. 139p. Dep. NTIS.

Information presented in the course is included in sections on once-through steam generators, principles of drum-type versus once-through steam generators, general and specific design features of Fort St. Vrain steam generator, and research associated with Fort St. Vrain steam generator. Twenty-seven appendixes containing information on testing, measurements, and materials properties are also included along with diagrams and tables. (J.R.D.)

9074 (SC-M-710510) DESCRIPTION AND OPERATING CHARACTERISTICS OF THE SANDIA LABORATORIES HEAT FACILITY. Hartman, G. J.; Adams, P. H.; Farnsworth, A. V. Jr. (Sandia Labs., Albuquerque, N. Mex.). Oct 1971. 37p. Dep. NTIS.

Description of the Sandia high-enthalpy arc tunnel (HEAT) facility includes details of the vortex-stabilized DC arc heaters, the cooling water systems, the 5-MW DC power supply and the vacuum system. The nominal operating envelopes for the facility with 4-inch, 8-inch, and 12-inch nozzle exit diameters are presented, and the ability to program a variation in heating rate to a test item is represented by a typical test profile. The computer-controlled data acquisition system used for facility monitoring, as well as for data collection and reduction, is described. (auth)

9075 CONTAINER FOR BLENDING DISPERSED POWDERS AND HOMOGENEITY DETERMINATION. Chakraborty, A. K.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Int. J. Powder Met.; 7: No. 4, 3; 5-6(Oct 1971).

A mechanical device which acts as a blending container and also allows samplings of individual layers of powder blends without appreciably disturbing the neighboring layers is described. The device consists of an open aluminum cylinder 9-½ in. high and 4 in. in diameter, with a tight-fitting cylindrical lid. The whole cylinder with the lid can be inserted into an oblique blender, and powders in different proportions can be blended for different amounts of time. Determination of the green density, segregation, and homogeneity of the powdered blends, as a function of blending layers and time, can be achieved by scanning the filled trays in the device by x-ray and measuring the attenuation. The container device represents a real simplification of the sampling of the powdered particles because the enclosed powders can be directly scanned for the blending homogeneity and marks a deviation from the time-consuming method of particle counting from small samples. (P.C.H.)

9076 ECONOMICS OF RADIATION VERSUS HEAT-CATALYST CURING FOR WOOD-PLASTIC FLOORING PLANT. Taylor, G. B.; Dietz, G. R.; Duff, R. M. (Radiation International, Inc., Parsippany, N. J.). Nucl. Technol.; 13: No. 1, 72-7(Jan 1972).

Several commercial companies are now producing wood-plastic flooring materials. Initial research indicated that either cobalt-60 or heat-catalyst combinations could be used for the polymerization sequence. The capital and manufacturing costs for each type of plant, based on an annual throughput of six million square feet are evaluated, and various production considerations which led to the choice of cobalt-60 as the preferred method for polymerization are discussed. (auth)

9077 APPARATUS FOR RADIOACTIVE IRRADIATION OF SAMPLE MATERIALS. Melillo, Anthony P.; Corea, John E. (to Radiation Resources, Inc.). U. S. Patent 3,604,934. 14 Sep 1971. Filed 10 Sep 1968.

Apparatus for the irradiation of sample materials is described. A housing contains a substantially centrally located cavity containing radioactive material. Horizontally disposed cylindrical passages have vertical axes and communicate with the central cavity, the passages being spaced from each other about the central cavity. Each passage contains a coaxial cylindrical rotatable carrier. Each carrier has a seat for containing a sample to be irradiated. The seat, recessed into the peripheral wall of the carrier, is horizontally registrable with the central cavity upon rotation of the carrier. A plurality of the carrier seats are thus simultaneously or selectively exposable to the source of radiation. (Official Gazette)

9078 IMPROVEMENTS IN OR RELATING TO COMPOSITE PRESSURE VESSELS. Thompson, Peter John; Tomkins, Brian (to United Kingdom Atomic Energy Authority). British Patent 1,250,608. 20 Oct 1971. Filed 4 Dec 1967.

Reference is made to pressure vessels that comprise two or more annular rings fitted concentrically within one another. It is present practice to design such pressure vessels with an interference fit at the contacting surfaces of the rings, so that the outer rings prestress the inner rings and the latter are subjected to a compressive loop stress. This increases the effective pressure capacity of the vessel and is thought to improve its fatigue life under cyclic pressure variations. The rings are either cold pressed together, or the outer rings are shrunk on to the inner-rings after heating the former. These methods of fitting the rings together limit the closeness of the interference fit and the extent to which the vessel can be prestressed. In the design described an inner angular ring fits concentrically within an outer ring and an interlayer of soft metal is provided within the interspace between the rings; hard metal pressure rings are fitted at the ends of the interspace between the rings with means, such as tension bolts, to force the pressure rings towards each other along the interspace so as to compress the soft metal interlayer. (UK)

9079 ASPECTS OF PRESTRESSED CONCRETE PRESSURE VESSELS. Ide, A. (Fuji Electric Co. Ltd., Tokyo). Genshiryoku Kogyo; 17: No. 3, 16-20(Mar 1971). (In Japanese).

Prestressed Concrete Pressure Vessels (PCPVs) which will overcome limits of steel RPVs and are expected to be most promising for gas reactor vessels, as well as reactor containment vessels, are discussed. Structural materials of the PCPVs are concrete, prestressing system, steel for reinforced concrete, liners and heat insulating materials. The bulk concrete used is irradiated by heat and radiation. Tendons, tendon tubes, and fixing instruments are given the general name of the prestressing system. Stabilized PC steel wires may be better than PC steel wires for tendons. Anticorrosive treatment of the tendons is especially important. Ordinary steel bars for the reinforced concrete may be used. The liners must be weldable, and closely follow the deformation of the PCPVs. The heat insulating material must tolerate temperature variation of some hundred degrees. Preciseness of stress analysis, which is needed in design of the PCPVs, depends upon precise knowledge of the characteristics of the concrete. The analysis of discontinuous parts must depend on model testing. During PCPV construction special attention must be paid to the liners. The finished PCPVs are subjected to pressure tests at 1.15 times design pressure. When PCPVs are constructed in Japan, seismic conditions for Japan are considered in safety evaluations. Design standards for PCPVs must be established. (Japan)

9080 FLUIDIZED BED FOR CONTINUOUS OPERATION. Souillart, Claude (to EURATOM). British Patent 1,251,853. 3 Nov 1971. Filed 13 Jun 1969.

A continuous fluidization process is described for coating particles such as nuclear fuel particles with graphite and/or Si. The disadvantages of conventional fluidized beds are enumerated. The apparatus employed is in the form of a channel disposed horizontally, or at a small inclination to the horizontal, and is substantially angular in cross section. At one end it has an outlet for continuously charging particles and at the other end an outlet for continuously discharging particles. The lateral surfaces of the channel form an angle which increases from the charging end towards the discharging end, and the bottom of the channel has a series of independent jets for introducing the gas mixture used for fluidization and deposition. An arrangement is provided for displacing the particles from the charging end towards the discharging end, such as by a small slope in the channel, or inclination of the jets, or vibration of the chamber, and advance of the particles may be arranged to keep the bed depth substantially constant. The channel may be straight or curved. (UK)

9081 BATTERY OF RECYCLING MIXER-SETTLERS. Faudot, Gerard; Lamotte, Claude (to Commissariat a l'Energie Atomique). French Patent 2,055,947. 14 May 1971. Filed 8 Aug 1969. (In French).

A battery of recycling mixer-settlers is described. The equipment consists of a series of stages, each incorporating a mixer, which receives a heavy phase and a light phase, constituting the giving and receiving phases respectively. The phases are mixed; a settler receives the two phase mixture from an overflow vessel. Each stage is provided with a means of sampling the light phase and the heavy phase from the settler, and a means of feeding a distributor connected to the mixer of the same stage or those of adjacent stages. The distributor possesses an adjustable part for regulating (for one of the phases) the ratio of the flow, which is recycled, to that sent to the following stage in the sense of the circulation. (France)

9082 CONTINUOUS SINTERING FURNACE. Aubry, Bernard; Gillot, Jacques; Masselot, Yves; Teboul, Albert (to Commissariat a l'Energie Atomique). French Patent 2,055,946. 14 May 1971. Filed 8 Aug 1969. (In French).

A furnace and the associated equipment used for sintering pellets of ceramic nuclear fuel in a neutral or reducing atmosphere is described. The process is intended particularly (although not exclusively) for pellets of uranium oxide and/or plutonium. It consists of a tubular enclosure with a horizontal axis, provided with a means of being heated along its length, a hearth for moving longitudinally the boats containing the pellets. A circuit is incorporated for maintaining a neutral or reducing atmosphere and for extracting the bonding agent. This circuit consists of a means of injecting the neutral or reducing gas into the two ends of the furnace, a means of removing the gas from the intermediate region between the pre-sintering and sintering regions, and a means of condensing the bonding agent which is found in this region. The system possesses a means of introducing the boats at one end of the furnace, moving them along the hearth, and extracting them from the other end of the furnace. (France)

9083 COMMERCIAL GAMMA-IRRADIATION PLANT IN SWEDEN. Crawford, C. G. (Radona Irradiations AB, Skaerhamn, Sweden). Isotop. Radiat. Technol.; 9: No. 2, 204-7 (Winter 1971-1972).

A description is given of the Radona 215 kCi γ-irradiation plant in Sweden. The plant is used mainly for sterilization of single-use medical products, ranging in size and complexity from simple blood lancets and needles to peritoneal dialysis and tube sets for heart-lung machines. (P.C.H.)

9084 REMOTELY ACTUATED TELEVISION SYSTEM. Kosky, R. P. (Combustion Engineering, Inc., Windsor, Conn.); Bagley, R. O. pp 172-5 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A remotely actuated television system has been designed that will position and manipulate a television camera to perform visual examinations of nuclear reactor pressure vessel internals. While complying with the requirements of the ASME Boiler and Pressure Vessel Code, Sec. XI, it may also be used for nonrelated visual examinations. Examination of the core barrel stabilizing lugs, vessel cladding, fuel bundles, and other reactor internals can be performed with the core barrel and fuel in place. The device is capable of being inserted into areas as small as 3 in. in diameter and will operate at distances in excess of 55 ft. Design of the mast section permits sufficient flexibility to maneuver around obstructions located between the operator and the subject being examined. (auth)

9085 PLURAL SPENT-REACTOR-FUEL DISSOLVERS HAVING SELECTIVE FEED MEANS. Ayers, Arnold L. (to Allied Chemical Corp.). U. S. Patent 3,607,107. 21 Sep 1971. Filed 4 Sep 1968.

A process for the dissolution of spent nuclear reactor fuel, while simultaneously controlling the amount of volatile off-gases evolved during the dissolution, is described. The process consists of passing spent nuclear reactor fuel in regulated amounts through a dissolvent solution, continuously withdrawing the volatile off-gases which are evolved, withdrawing a portion of the solution of spent nuclear reactor fuel when a predetermined maximum concentration of fuel values is reached in the solution, adding a compensating volume of dissolvent solution, and continuously recirculating the remaining portion of the solution of spent nuclear reactor fuel to the dissolution step. In a preferred mode of operation two dissolver systems are employed and fuel to be dissolved is fed to one dissolver system while the other dissolver system is being washed, discharged and readied for another dissolution cycle. Novel apparatus for carrying out the above-described process comprises one or more dissolving units equipped with means for feeding spent nuclear reactor fuel, in a controlled manner, to a particular member or members of the dissolving units. A removable perforated basketlike member is inserted in the fluid-retaining main housing member to receive and position the fuel for contact with the dissolvent solution. After dissolution is complete the basketlike member containing the leached hulls may be removed and replaced with an empty basket for another dissolution cycle. In a preferred embodiment, two dissolution units are employed. (TSS) (Official Gazette)

9086 CRYOSTAT FOR ANNEALING SPECTRA MEASUREMENTS WITH SHORT RISE TIME TO THE ANNEALING TEMPERATURE. Andronikos, P.; Olympios, E.; Papathanassopoulos, C. (Democritos Nuclear Research Centre, Athens). Radiat. Eff.; 10: No. 4, 215-18(Sep 1971).

A simple cryostat for annealing spectra measurements in the temperature range 78 to 700°K is described and its specifications are given. The rise time at the annealing temperature is chosen equal to 1.5 minutes, giving thus, a practically square shape of the temperature pulse. An analogue valve regulates automatically a stream of cold nitrogen gas and maintains the temperature of the samples constant within ±0.05°C. The rise time varies from 1 min, or even less, to about 7 min, when there is no control of temperature through the cold gas. (auth)

9087 DESIGN FEATURES OF LARGE WET STEAM TURBINES FOR NUCLEAR GENERATING STATIONS. Usher, J. (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.). Eng. J. (Montreal); 54: No. 10, 41-5(Oct 1971).

Design and constructional features of the large wet steam turbines which are currently being manufactured in England for the Canadian market are described. The high-pressure and low-pressure turbines are described in detail and the reasons for particular features are given. Water separation devices, internal- and external-to the turbine, are described and illustrated, and reference is made to the live steam reheater design. Control aspects of wet steam turbines are discussed. (auth)

9088 FURNACES FOR THE NUCLEAR INDUSTRY. Tech. Mod.: 63: No. 7, 271-2(Jul 1971). (In French).

Two new types of furnace for manufacturing reactor vessels are described: a furnace for manufacturing the metallic sheets and the forged skirting, and a thermal treatment furnace. (France)

9089 INDUCTION HEATING DEVICE FOR SUCCESSIVE BARLIKE MEMBERS. Balzer, Norbert R. (to United States Atomic Energy Commission). U. S. Patent 3,612,804. 12 Oct 1971. Filed 31 Dec 1968.

An improvement in an induction heating apparatus for heating a succession of abutting barlike members is described. The apparatus includes an elongated multiturn induction heating coil with an elongated internal passageway through which the members pass, a power supply means for energizing the coil with an alternating current, and means extending between the entrance and exit of the passageway for guiding members through the passageway on a selected path. The improvement consists of forming the guide means with an elongated element with a contoured portion between the entrance and exit of the passageway which contoured portion creates a gradual offset in a selected transverse direction to the path so that the members do not pass through the coil with their abutting ends in full contact with each other. (Official Gazette)

9090 AMBIENT RADIOACTIVITY AIR FILTER TESTER USING A TRACK-REGISTRATION MATERIAL. Alter, Henry Ward; Gilbert, Richard S. (to General Electric Co.). U. S. Patent 3,614,421. 19 Oct 1971. Filed 12 Dec 1968.

An improved technique for testing air filtration systems is disclosed. So-called "absolute" filters are intended to remove substantially all of the suspended particles from a stream of air passing through them. Track-registration films sensitive to alpha particles emitted by radon daughters are placed upstream and downstream of the high-efficiency filter banks. After a suitable period, the exposed films are developed. The ratio of downstream to upstream track density is a direct measure of filtering efficiency. This system is much more sensitive, convenient and simple than prior filter-efficiency-testing techniques. (Official Gazette)

9091 METHOD AND DEVICE TO MEASURE THE SPEED OF WATER IN A POLYPHASE FLOW. Allaud, Louis A. (to Schlumberger Technology Corp.). U. S. Patent 3,603,795. 7 Sep 1971. Priority date 26 Dec 1967, France.

An illustrative embodiment of the invention measures water speed through oxygen activation. Typically, neutrons of sufficient energy to initiate $^{16}O(n,p)^{16}N$ reactions irradiate a fluid stream, as for example, the usual polyphase stream of fluids flowing through the borehole of a producing oil well. Two gamma detectors spaced at different distances from each other downstream from the neutron source register the 6 MeV gamma radiation that characterizes ^{16}N disintegration. The water speed then is determined through the ratio of the counts registered by the two detectors. (Official Gazette)

9092 LOVELACE AEROSOL PARTICLE SEPARATOR (LAPS) (10 Jun 1971) (Engineering Materials). (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Dept. of Aerosol Physics). (CAPE-2145).

4 drawings.

An aerosol particle separator is described that provides continuous separation of aerosol particles in the micron and submicron size ranges according to their aerodynamic equivalent diameters using the principle of centrifugal separation of particles in a spinning spiral duct. The separator is essentially a spinning rotor driven by a motor at a desired constant speed. An

aerosol sample is drawn into an expanding spiral duct through an inlet at the axis of the rotor, and is entrained in a laminar stream of clean air and drawn by negative pressure through the channel. The particles are deposited according to their aerodynamic diameters along a collecting foil lining the outer wall of the duct with the very small particles on a filter at the exit end of the spiral, thereby providing a continuous separation of aerosol particles in the entire size range of interest. The separator is suitable for separating aerosol particles for a variety of purposes including analysis of aerodynamic particle size distribution, preparation of monodisperse particles, measurement of densities of spherical aerosol particles, and measurement of particle shape factors. The separator has no loading limitations or wall losses, which allows it to be used as a standardization device for other aerodynamic samples such as cascade impactors. (For details see TID-4100 Suppl. 67) (F.S.)

9093 HEATED INFRARED SAMPLE CELL (13 Nov 1970) (Engineering Materials). (Goodyear Atomic Corp., Portsmouth, Ohio). (CAPE-2138).

2 drawings.

A heated infrared sample cell for volatile fluorides is described. Pure Ni construction is used to resist fluoride corrosion. The Ag Cl windows are coated with a thin layer of MgF_2 to resist attack by F. Window gaskets of Teflon are cooled by coils placed in the cell body under the sealing gaskets to prevent softening which occurs when Teflon reaches 100°C. The cooling fluid (distilled water and glycol) is pumped by a peristaltic pump. The flow rate of the pump is proportional to the pump speed. Before the cooling fluid enters the cell, it is pumped through a heat exchanger to bring the fluid to a uniform temperature of about 10°C. The windows transmit infrared radiation in the range needed for volatile fluorides. The sample space is in the shape of a truncated cone to match the shape of the focused infrared beam. To provide efficient sample heating, the outside of the cell is also tapered and wrapped with Nichrome wire. The heat that is supplied to the sample cavity by the Nichrome wire is controlled by a powerstat voltage regulator. Thermocouple wells, located in the cell body at each end in front of the cooling coils and in the center of the cell, provide information on gas temperature, level, and gradients. Gases are introduced using vacuum transfer techniques into an inlet located in the center of the cell. (For details see TID-4100 Suppl. 67) (F.S.)

9094 IRRADIATION FACILITY AT CADARACHE. Cercy, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 75-9(Apr 1971). (In French).

The irradiation facility at the Cadarache nuclear center is described; it was designed in such a way as to minimize unwanted scattering in radiation field propagation and irradiation studies. The building arrangements incorporate all the facilities and conveniences required and external collaboration is encouraged. New devices, which have been developed or which are being developed in a wide range of fields such as the testing and calibration of equipment, the perfection of safety techniques concerned with large industrial plants, and the acquisition of data on γ ray, neutron, or mixed field propagation, are described. (France)

9095 DEVICE FOR MACHINING A SPHERICAL CAVITY INSIDE A SOLID WITH A SYMMETRY OF REVOLUTION, PARTICULARLY INSIDE A SPHERE. (to Societe le Carbone Lorraine). French Patent 2,056,024. 10 Apr 1971. Filed 20 Aug 1969. (In French).

A device for machining a spherical cavity of radius R inside a solid with a symmetry of revolution, is described, the most important application envisaged being the interior of the graphite spheres used as cladding for nuclear fuel elements. The cutting tool consists of a cutting wheel of radius r, whose center moves along a semi-circumference of radius R-r in the meridian plane, which contains the axis of the access bore, the access bore being relatively small. (France)

9096 TESTING OF SODIUM PUMP. Fakkel, R. H. NERATOOM, N V, The Hague); Vroom, J. P.; Mendte, K.; Lameris, H. J. Nucl. Eng. Int.; 16: No. 187, 1006-8(Dec 1971).

A summary is given of the results of testing a 5000 m^3/h sodium pump in the large APB pump test facility of Interatom. The pump is a full scale prototype circulating pump for use in the SNR fast breeder reactor and is the largest Na pump yet running under actual operational conditions. Results are reported for hydraulic performance of the pump, gas leakage measurements of mechanical seals, and behavior of the sodium-lubricated hydrostatic bearing at low speeds. (UK)

9097 SODIUM PUMPS FOR PHENIX. Hispano-Suiza. Nucl. Eng. Int.; 16: No. 187, 1002-4(Dec 1971).

Many new problems encountered during the development and manufacture of the sodium pumps for Phenix are described. Even if there is no application for exact replicas of the Phenix pumps in the next generation of fast nuclear power stations of 1000 to 2000 MW(e), because of their relatively low flow rates, many existing sub-assemblies may be re-used either in their present form or after scaling up to a limited extent. (auth)

9098 IMPROVEMENTS TO HEAT EXCHANGERS. (to Societe Babcock-Atlantique). French Patent 2,061,516. 25 Jun 1971. Filed 11 Mar 1969. (In French).

An invention principally concerning heat exchangers utilizing costly or dangerous fluids, the volume of which must be minimized, is described. The heat exchanger contains in an envelope, with a symmetry of revolution, a chamber enclosing an assembly of heat exchange surfaces for the two fluids. This chamber presents at one of its ends, an extension, which is axial and located around the periphery, where it forms an annular space for admitting and/or evacuating one of the two fluids. (France)

9099 CONTINUOUS VACUUM CASTING, EXPERIMENTAL FURNACE. Guichard, C.; Soret, J. C. (Societe Industrielle de Combustible Nucleaire, Veurey, France). Vide; 26: No. 152, 76-9(Mar 1971). (In French).

A process for the vacuum induction melting and continuous casting of an ingot, the ingot being continuously withdrawn from the vacuum chamber into the free atmosphere has been developed. The pilot machine consisting of pumping system, equipment for controlling the liquid metal flow rate, dynamic vacuum sealing, secondary cooling, withdrawal rollers, and flying saw is described. This machine is used to cast U rods (fuel elements for the French graphite gas reactors). This process could be applied to other metals. (France)

9100 IMPROVEMENTS TO HEAT EXCHANGERS. (to Societe Babsock-Atlantique). French Patent 2,061,513. 25 Jun 1971. Filed 7 Mar 1969. (In French).

A heat exchanger consisting of a bundle of straight parallel tubes leading to a collecting wall, which is in the form of a nonplanar surface of revolution, is described, the tubes being connected to this wall by a series of elbow joints. Provided that this wall has a uniform thickness, a nonplanar form increases its pressure resistance and the terminal elbows reduce the stresses on the tube walls. These properties enable higher circuit pressures to be used with thinner collecting walls. The case is envisaged in which the collecting wall forms part of an envelope defining a chamber containing the bundle of tubes. This collecting wall may be in the form of a skirting enlargement of the cylindrical envelope or a hemisphere forming the base of such an envelope. (France)

9101 ULTRASOUND TRANSDUCER OPERATING INSIDE A LIQUID AT HIGH TEMPERATURE. Marini, Jean; Roule, Maurice (to Commissariat a l'Energie Atomique). French Patent 2,063,324. 9 Jul 1971. Filed 12 Sep 1969. (In French).

An ultrasound transducer, which can operate at high temperature within a liquid, is described. Its principal use is in the remote location of mechanical parts immersed in the liquid Na or NaK of a liquid metal cooled reactor. The transducer consists of a sealed enclosure with a plane wall, whose thickness is an integral number of half wavelengths of the acoustic wave set up by a piezoelectric pellet; it possesses a system for applying or sampling the potential difference between the vibrating faces of the pellet and an electrically insulating material, which encloses this system, and isolates it from the walls of the enclosure. (France)

9102 CASELLA Mk. 2 CASCADE IMPACTOR: A COMPARISON OF OBSERVED WITH CALCULATED STAGE MASS MEDIAN DIAMETERS. Soole, B. W. (Admiralty Research Lab., Teddington, Eng.). J. Aerosol Sci.; 2: No. 3, 281-8 (Aug 1971).

Observed mass median diameters of deposits obtained on the various stages of a Casella Mk. 2 cascade impactor by sampling particles approximating to log-normal distributions of known characteristics are compared with calculated values. While good agreement is found for drops and other spherical particles when due allowance is made for differences of particle density and rates of aspiration, discrepancies are noted for particles of other shapes. These differences may be explained by assuming that optically observed diameters of non-spherical particles are appreciably greater than corresponding aerodynamic diameters. It is therefore concluded that stage mass median diameters and other characteristic diameters theoretically derived from stage penetration curves obtained from experiments with spherical particles must be used with caution for the construction of cumulative distribution curves from deposits of particles with other shapes. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 9072, 9087, 9098, 9100, 9201, 9785, 10129, 11330, 11331, 11348, and 11350.

9103 (AEEW-M-1000) ESTIMATION OF TUBE WALL TEMPERATURES IN THE EVAPORATOR REGION OF SUBCRITICAL ONCE-THROUGH SODIUM HEATED STEAM GENERATORS. Bailey, N. A.; Collier, J. G. (Atomic Energy Establishment, Winfrith (England)). Aug 1970. 19p. Dep. NTIS (U. S. Sales Only).

Available information on the magnitude of the surface temperature rise resulting from dryout in a highly rated subcritical once-through steam generator is reviewed, and the influence of such parameters as heat flux, mass velocity, pressure, and tube diameter is discussed. A method is proposed whereby the water side heat transfer characteristics determined using electrically heated tubes may be used to estimate the variation in tube wall temperature in a sodium-heated steam generator, and the uncertainties involved just downstream are discussed. (auth)

9104 (AERE-M-2436) MODEL FOR PREDICTING DRYOUT IN A TUBE WITH A CIRCUMFERENTIAL VARIATION IN HEAT FLUX. Butterworth, D. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 13p. Dep. NTIS (U. S. Sales Only). UK 9p.

A film-flow model is proposed for predicting dryout in a tube with a circumferential variation in heat flux. The model involves a two-dimensional continuity equation for the film and a coefficient to represent circumferential spreading of the film. The Kirby model is used for predicting the net droplet deposition flux. The final model is found to be compatible with some experimental data and to lead to a burnout equation which is a modified Thompson-Macbeth form. (auth)

9105 (CEA-CONF-1859) REVIEW OF TWO-PHASE FLOW INSTABILITY. Boure, J. A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Bergles, A. E. (Georgia Inst. of Tech., Atlanta); Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa.). 1971. 20p. (CONF-710822-1). ASME $3.00.

From twelfth national heat transfer conference; Tulsa, Okla. (15 Aug 1971).

The causes and mechanisms of thermal-hydrodynamics instabilities occurring in the boiling flow in water-cooled reactors, evaporators, or electronics cooling systems are identified. Instabilities can generate flow oscillations of constant or diverging amplitudes and the oscillations can induce boiling crisis, disturb control systems or cause mechanical damage. Various types of instabilities are classified and tabulated according to their mechanisms. The parametric effects on flow instability, experimentally observed, are systematically discussed. The various analytical methods used for predicting instability thresholds are reviewed in terms of their applicability and accuracy. (France)

9106 (RD/B/N-2105) TURBULENT FLOW AND HEAT TRANSFER IN THE RECIRCULATING REGION BETWEEN TUBULAR FUEL ELEMENTS. Kacker, S. C.; Durham, M. E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct 1971. 49p. Dep. NTIS (U. S. Sales Only).

Pressure distribution and variation in Stanton number in a situation representing the gap between tubular fuel elements were investigated, both experimentally and using a numerical prediction procedure. Some measure of agreement was found between the two methods, but the prediction procedure required certain empirical inputs, which were specific to the configuration under investigation. (auth)

9107 TERMODINAMICHESKIE I TEPLOFIZICHESKIE SVOISTVA GELIYA. (Thermodynamic and Thermophysical Properties of Helium). Tsederberg, N. V.; Popov, V. N.; Morozova, N. A. Moscow; Atomizdat (1969). 276p.

Thermodynamic and thermal properties of helium in the pressure range 0.2 to 200 bar and temperature range 0 to 3000°C are considered. The equation of state of helium is derived, from which thermal properties are calculated. Thermal capacity, enthalpy and entropy of helium in an ideal-gas state are calculated, using the rules of statistical thermodynamics. The effect of gas reality on caloric properties is taken into account. Equations describing the thermal conductivity and viscosity of helium in the aforementioned pressure and temperature ranges are presented. Extensive tables and figures are included. (tr-auth)

9108 HEAT TRANSFER 1970. VOLUME II. Papers Presented at the Fourth International Heat Transfer Conference, Paris-Versailles 1970. Grigull, Ulrich; Hahne, Erich (eds.). Amsterdam; Elsevier Publishing Company (1970). 316p. (In several languages). (CONF-700805-(Vol.2)).

Fifty papers presented at the Fourth International Heat Transfer Conference are included in this volume. A separate abstract was prepared for each of 7. Forty-three papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 9109-9113, 10129, and 10130.

9109 FORCED-CONVECTIVE LAMINAR FLOW HEAT TRANSFER IN THE ENTRANCE REGION OF A TUBE. Butterworth, D. (Atomic Energy Research Establishment, Harwell, Eng.); Hazell, T. D. pp FC3.1.1-11 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris-Versailles, France (31 Aug 1970).

Theoretical and experimental studies on laminar flow entrance region heat transfer are described. The particular aspect of the problem chosen for study was that in which heating is started at different stages of flow development. In the experimental study, local heat transfer coefficients were measured in an electrically heated horizontal tube using glycerol/water mixtures as the heat transfer medium. The range of experimental Prandtl numbers studied was 60 to 550. Natural convection and variable fluid property effects were kept to a minimum by using a small bore tube and low heat fluxes. The experimental results showed close agreement with the theoretical model. (auth) (France)

9110 HEAT TRANSFER IN THE ENTRANCE REGION OF AN ANNULUS. Furber, B. N.; Green, W. J.; Vivian, W. R. (Nuclear Power Group Ltd., Knutsford, Eng.). pp FC3.3.1-11 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris-Versailles, France (31 Aug 1970).

An experiment for determining local heat transfer coefficients for the entrance region of an annulus in which only the inner surface was heated is described. Correlated heat transfer results are given for annulus diameter ratios of 1.47 and 1.96 and for surface temperatures up to 1000°C corresponding to a surface to bulk gas temperature ratio of 3. Annulus Reynolds numbers were mainly between 1×10^5 and 6×10^5 and high pressure carbon dioxide was the coolant. (auth) (France)

9111 CONTRIBUTION TO THE STUDY ON FORCED CONVECTION ON CORRUGATED SURFACES. Geffroy, J.; Jude, P.; Paumard, G. (CEA, Saclay, France). pp FC5.1.1-11 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970). (In French).

From fourth international heat transfer conference; Paris-Versailles, France (31 Aug 1970).

The aerothermal characteristics obtained experimentally with internally corrugated circular tubes (sinusoidal corrugations) were studied. The aerodynamic study of an air flow along a bundle of externally corrugated slugs placed in a smooth circular channel parallel to the flow was made. The distribution of the local frictional forces on the walls of the bundle were deduced from the results of the circular tube, which has a homothetic corrugation and from the range of velocities. It is shown that the integral of the frictional forces thus determined is in agreement within 1% with the integral deduced from the direct measurement of the pressure drop. (auth) (France)

9112 EFFECT OF PHYSICAL PROPERTY VARIATIONS ON HEAT TRANSFER FROM ROUGHENED SURFACES. Walker, V. (Univ. of Bradford, Eng.); White, L. pp FC5.4.1-11 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris-Versailles, France (31 Aug 1970).

The influence of the coolant physical property changes normal to the heat transfer surface, arising from the temperature variation T_w to T_b, on heat transfer from systematically roughened surfaces as used in Advanced Gas-Cooled Reactors was studied. Experiments were performed with nitrogen and carbon dioxide at relatively low temperatures to provide a basis for a correlation applicable to a range of reactor conditions. The practical problem was solved but in the process fundamental difficulties were encountered, and a critical discussion of the types of correlation which have commonly been used to embrace physical property variations is made. (auth) (France)

9113 DEVELOPMENT OF ROUGH SURFACES WITH IMPROVED HEAT TRANSFER PERFORMANCE AND A STUDY OF THE MECHANISMS INVOLVED. Williams, F.; Watts, J. (Central Electricity Generating Board, Berkeley, Eng.). pp FC5.5.1-11 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

The heat transfer and pressure drop performance of three basic types of rough surfaces were investigated. The results are presented in terms of Stanton number, friction factor, and thermal performance. To discover the reasons for the differences in performance, large scale models were employed. Distributions of heat transfer coefficient were obtained using a mass transfer analogy technique and flow patterns were analyzed, both visually and photographically. Finally, using the measured heat transfer coefficients, surface temperature distributions were derived. The results of these investigations led to a better understanding of the basic mechanisms involved in rough-surface heat transfer. (auth) (France)

9114 HEAT TRANSFER 1970. VOLUME IV. Papers Presented at the Fourth International Heat Transfer Conference, Paris–Versailles 1970. Grigull, Ulrich; Hahne, Erich (eds.). Amsterdam; Elsevier Publishing Company (1970). 306p. (In several languages). (CONF-700805-(Vol.4)).

Forty-nine papers presented at the Fourth International Heat Transfer Conference are included in this volume. A separate abstract was prepared for each of 5. Forty-four papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 9115–9119.

9115 NATURAL CONVECTION IN ANNULAR AND RECTANGULAR CAVITIES. A NUMERICAL STUDY. Thomas, R. W.; de Vahl Davis, G. (Univ. of New South Wales, Kensington, Australia). pp NC2.4.1-11 of Heat Transfer 1970. Vol. IV. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

An analysis was made of the motion and heat transfer resulting from laminar natural convection in a closed vertical annulus, the inner surface of which is at a higher temperature than the outer. A numerical solution of the Navier–Stokes and energy equations was obtained. The phenomena were found to be strongly dependent upon the Rayleigh number and the cavity geometry, and almost independent of the Prandtl number. Correlations for the overall Nusselt number for three different flow regimes have been obtained. A secondary flow, induced at a critical Rayleigh number and causing multicellular motion, was studied. (auth)

9116 NATURAL CONVECTION THROUGH NARROW VERTICAL UNHEATED ANNULI AT HIGH GAS PRESSURES. Collier, J. G.; Boyce, B. E.; deForge Dedman, A. S.; Khanna, R. (Atomic Power Constructions Ltd., Heston, Eng.). pp NC2.6.1-10 of Heat Transfer 1970. Vol. IV. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Natural convection through narrow vertical annuli was studied in connection with the design of a gas-cooled nuclear reactor. Methods of restricting the heat convected through the annular gap were examined experimentally using carbon dioxide in a pressurized rig. These studies included a range of annular geometries and experimental conditions covering pressures up to 3.1×10^6 N/m^2 and temperatures up to 675°C. Further work was carried out in a low-temperature Perspex rig using water. The flow patterns are described and quantitative measurements made with the water rig related, by the use of non-dimensional groupings, to similar measurements made in the pressurized gas equipment. (auth) (France)

9117 HEAT TRANSFER AND FLUID FLOW IN THE CLOSED THERMOSYPHON. Japikse, D.; Winter, E. R. F. (Purdue Univ., West Lafayette, Ind.). pp NC2.9.1-11 of Heat Transfer 1970. Vol. IV. /Gribull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

An analytical and experimental study of the single component, single phase closed thermosyphon with laminar and turbulent boundary layer flow is presented. In the experimental study, a transparent test cell was employed so as to directly observe the transport processes which were found to be basically convective. Experiments, with Prandtl numbers from 4 to 940, were conducted for overall temperature differences of one, three, and nine degrees centigrade for which the temperature field was measured. A convective model, showing good agreement with experimental heat transfer data, is formulated for the analytical study. (auth) (France)

9118 THEORETICAL STUDY OF COMBINED NATURAL AND FORCED LAMINAR CONVECTION FOR DEVELOPING FLOW DOWN VERTICAL ANNULI. Sherwin, K. (Univ. of Liverpool); Wallis, J. D. pp NC3.9.1-9 of Heat Transfer 1970. Vol. IV. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Laminar flow systems were studied in which buoyancy modifies the forced flow, and the previous theoretical work on fully developed flows in vertical annuli with uniform heat flux at the inner surface was extended to a consideration of developing flows in which appreciable radial velocities exist. The application of a finite difference iterative computer technique is presented which was found to be workable well into the stable reversed flow regime and gives results for flow reversal in good agreement with the previously reported experiments. For a radius ratio of 3, results are presented of axial velocities, radial velocities, temperature, and local Nusselt number. (auth) (France)

9119 EFFECTS OF ACOUSTIC VIBRATIONS ON THE COOLDOWN TIME OF BODIES IN CRYOGENIC LIQUIDS. Loosle, David G.; Holdredge, Russell M. (Utah State Univ., Logan). pp NC4.6.1-11 of Heat Transfer 1970. Vol. IV. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

The quantitative effects of acoustic vibrations on the cooldown rate of bodies from room temperature to liquid nitrogen or liquid helium temperature were investigated. The influence of frequency, acoustic intensity, Biot number, and location of specimen with the respect to the sound transducer were determined. Extensive results in liquid nitrogen indicated there is a critical sound pressure level below which there was no effect and above which there was a linear reduction in cooldown time. The results were correlated using the techniques of similitude. An attempt was made to verify the correlating equation using liquid helium as a coolant. (auth)

9120 HEAT TRANSFER 1970. VOLUME VI. Papers Presented at the Fourth International Heat Transfer Conference, Paris–Versailles 1970. Grigull, Ulrich; Hahne, Erich (eds.). Amsterdam; Elsevier Publishing Company (1970). 310p. (In German and English). (CONF-700805-(Vol.6)).

Forty-six papers on heat transfer studies of boiling and condensation were presented at the conference and are included in this volume. A separate abstract was prepared for each of 15. Thirty-one papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 9121–9135.

9121 PECULIAR TYPE OF BURNOUT IN EVAPORATIVE TUBES. Doroshchuk, V. E.; Lantsman, F. P.; Levitan, L. L. (All-Union Heat Engineering Inst., Moscow). pp B6.1.1-10 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Physical model burnout caused by drying out of wall liquid film is discussed. Investigation of the conditions of drops falling out of dispersed steam-water-flow core on liquid film in the heated tube was carried out. Experimental data on boundary steam quality in horizontal tubes and annulus are given. (auth)

9122 HEAT TRANSFER CRISIS AND FLUCTUATIONS WITH STEAM–WATER MIXTURES. Budajova, Elvira; Zeman, Vladimir (Technical Univ., Brno). pp B6.2.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

The problems of unsteady flow and the heat transfer crisis with steam-water mixtures are described. Results on the heat transfer crisis and oscillations with steam-water mixtures obtained at the Department of Heat Energy Equipment, Brno Technical University, Czechoslovakia, are reviewed and discussed. The results were compared with experimental and theoretical investigations of other laboratories in the world. These results may be used in power energetics for projection of steam boilers and nuclear stations. (auth)

9123 MODEL OF CRITICAL HEAT FLUX IN SUBCOOLED FLOW BOILING. Fiori, Mario P. (Massachusetts Inst. of Tech., Cambridge); Bergles, Arthur E. pp B6.3.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

The physical phenomena occurring before and at the critical heat flux (CHF) for subcooled flow boiling of water at moderate pressure are described. Photographic and electric probe studies with tubes and annuli established that the flow regime is slug or froth flow with intense nucleation at the heater wall. These observations suggested a new model of CHF based on the formation of a dry spot underneath a vapor clot. Wall temperature measurements, in conjunction with still or motion pictures, confirmed the microscopic features of the proposed model. The oscillatory wall temperature at CHF could be predicted with appropriate flow pattern inputs. The proposed model is shown to be qualitatively consistent with parametric trends, including the effect of wall thickness. (auth)

9124 SOME CONSIDERATIONS ON CRITICAL HEAT FLUX IN ROD CLUSTERS IN ANNULAR DISPERSED VERTICAL UPWARD TWO-PHASE FLOW. Gaspari, G. P.; Hassid, A.; Vanoli, G. (CISE, Segrate, Italy). pp B6.4.1-14 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Critical heat flux in rod clusters is being investigated at CISE in connection with the CIRENE reactor development (pressure tube, D_2O moderated, evaporating H_2O cooled). The studies are being carried out on 19-rod clusters (7-rod clusters have also been considered) to determine the influence of some geometrical parameters. The results so far obtained are summarized, in particular with reference to the influence of a number of parameters, such as rod diameter, rod spacing, length, number of rods, radial power distribution, etc. Experimental data are studied according to an approach based on a rod-centered subchannel division of the cross section. A brief analysis is also given of the limitations of the existing correlations. (auth)

9125 MEASUREMENTS OF CRITICAL STRESS IN HEATING SURFACES OF ROD BUNDLES WITH STEADY AND NONSTEADY OPERATING CONDITIONS. Hein, D.; Kastner, W.; Mayinger, F. (M.A.N.-Werk, Nuremberg). pp B6.5.1-12 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970). (In German).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Research was conducted on rod assemblies to determine the influence of radial heat flow distribution on the critical stress in the heating surfaces. In addition, measurements were made during heating excursions and with variations in total flow. The radial heat distribution raises a question concerning the mixing processes. The measured values of the critical heat flow density remain related to the corresponding quasi-stationary conditions during rapid heat excursions. The improvement is strongly influenced by the bundle geometry. The stable burnout relations are brought into play for variations in the total current flow. (tr-auth)

9126 EXPERIMENTAL STUDIES ON THE MECHANISMS OF BURNOUT IN HEAT TRANSFER TO STEAM–WATER MIXTURES. Hewitt, G. F. (Atomic Energy Research Establishment, Harwell, Eng.). pp B6.6.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

A number of related experimental studies relevant to the mechanisms of the burnout phenomenon is described. Using apparatus operating at low pressure ($2\text{-}4 \times 10^5$ N/m^2) measurements were made of equilibrium entrainment in adiabatic steam-water annular flow, the secondary effects of subcooling and wall thickness on entrainment and burnout were studied and the direct effect of heat flux on liquid entrainment in diabatic steam-water flow was investigated. Using a loop operating at 6.89×10^6 N/m^2, burnout heat flux measurements were made for steam-water flow in a tube of high L/D ratio, liquid film flow rate was determined at the end of a heated tube carrying steam-water flow and a special technique was developed for the estimation of water deposition rate normal to the heated surface. New results are presented to clarify and amplify the general picture of the mechanisms of burnout which were postulated in earlier studies. (France)

9127 LIQUID FILM BEHAVIOUR IN ANNULAR DISPERSED FLOW AT CRITICAL HEAT FLUX. Moeck, E. O. (McGill Univ., Montreal. Atomic Energy of Canada Ltd., Chalk River, Ont.); Stachiewicz, J. W. pp B6.7.1-14 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Liquid film flow rates and critical heat fluxes were measured in a concentric, internally-heated annulus with steam-water upflow at pressures and velocities of interest in nuclear reactors. At the boiling crisis the film broke down locally at the heater top but an appreciable film continued to flow around the dry patch onto an unheated deposition section. This residual flow was allowed to grow by droplet deposition over pre-determined lengths before being removed through a porous wall. From the growth rate of the new films, deposition fluxes were obtained, and an equation for the entrainment flux is proposed. (auth)

9128 BOILING HEAT TRANSFER CRISIS IN TUBES WITH DISPERSED ANNULAR FLOW OF STEAM–WATER MIXTURES. Smolin, V. N. (Inst. of Atomic Energy, Moscow). pp B6.8.1-10 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

A model of boiling heat transfer crisis based on experimental data obtained by the author for cylindrical tubes in the pressure range of 27.5 to 176 bars is presented. Mass velocities of 1000 to 5000 kg/m^2 sec, mass void fractions from 0 to 0.7, and flux densities up to 5 MW/m^2 were covered. The model involves the theory of hydrodynamic stability of gas-liquid systems. Formulas for calculating mass void fraction when hydrodynamic crisis occurs and heat flux density in dispersed annular flow of steam-water mixture are presented. (France)

9129 SCALING LAW OF FLOW-BOILING CRISIS. Tong, L. S.; Motley, F. E.; Cermak, J. O. (Westinghouse Electric Corp., Pittsburgh). pp B6.12.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

The simulation of flow-boiling crisis requires geometric and dynamic similitudes. The dynamic similitude implies both hydrodynamic and thermodynamic similitudes. A review of existing simulation technique for boiling crisis reveals that: the coolant properties at critical pressures can represent its thermal behavior at various pressures, the scaling factor is a function of the ratios of the critical properties of both coolants, the scaling factor can be applied to empirical correlations of critical power, enthalpy rise or quality. A new simulating model was proposed and its validity is demonstrated. The scaling factors for CHF in a rod bundle at various pressures are presented and verified with experimental data. (France)

9130 HEAT TRANSFER BURNOUT IN WATER FLOW THROUGH ROUND TUBES AND ANNULI. Zenkevich, B. A.; Kirillov, P. L.; Alekseev, G. V.; Peskov, O. L.; Sudnitsyn, O. A. pp B6.13.1-10 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Two approaches for the calculation of the heat transfer burnout based on the film models and droplet diffusion are discussed. The non-uniform heat distribution along the length of the reactor channel does not allow the burnout margin to be calculated on the basis of the specific heat fluxes. However, when the axial heat distribution is close to cosinusoidal, the heat transfer burnout in annuli can be predicted in terms of the burnout power though it is impossible to predict the location of the burnout inception. The burnout power in this case is estimated from the data for the uniformly heated annuli. When the axial heat flux distribution is of a complicated nature with a high ratio of non-uniformity the evaluation of the heat transfer burnout from the burnout power or burnout heat fluxes seems to be questionable and can lead to significant errors. Results of treatment of data are presented. (auth)

9131 EXPERIMENTAL INVESTIGATION OF TWO-PHASE PRESSURE DROP FOR POTASSIUM WITH AND WITHOUT NET VAPORIZATION. Chen, John C.; Kalish, Sheldon (Brookhaven National Lab., Upton, N. Y.). pp B8.3.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Pressure drops were measured for two-phase upward flow of potassium in vertical tubes. Data were obtained for both adiabatic and diabatic conditions, over a range of flow rates, absolute pressures, vapor qualities, and heat fluxes. The results were found to be well correlated by the simple annular-flow model, using an empirical equation for estimation of void fractions. (auth)

9132 SUPERHEAT CORRELATION FOR BOILING ALKALI METALS. Edwards, J. A. (North Carolina State Univ., Raleigh); Hoffman, H. W. pp B8.4-1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

A theoretical analysis that evaluates the maximum temperature a boiler wall must assume to promote stable boiling of alkali metals is presented. In the analysis it is shown that heat flux, bubble release angle, and nucleation site size may significantly affect the magnitude of the superheat required to sustain boiling. In addition, it is shown that their individual effects are interrelated. Experimental data are presented which support the theoretical development. The results reported were obtained when boiling potassium on surfaces with artificial cavities and on an as-received surface and cover a saturation temperature range of 750 to 1150°K and a heat flux range of 95,000 to 285,000 W/m^2. (auth)

9133 DYNAMICS OF THE BOILING PROCESS IN SODIUM-COOLED REACTORS. Peppler, W.; Schlechtendahl, E. G.; Schnultheiss, G. F. (Kernforschungszentrum, Karlsruhe, Ger.). pp B8.5.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970). (In German).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Experimental and theoretical investigations of the thermodynamic and hydrodynamic processes are reported with coolant perturbations in fuel elements of sodium-cooled fast reactors. The theoretically developed Code BLOW-2 and the model upon which it is based are both described. The dynamics of the ejection process of the liquid phase were investigated in various test arrangements for the boiling processes in simple geometries. The delay in boiling was studied as functions of artificial surface roughness and of surface contamination. The results of the investigations are interpreted. (tr-auth)

9134 STUDY OF THE INCIPIENT NUCLEATION OF LIQUID SODIUM. Singer, Ralph M.; Holtz, Robert E. (Argonne National Lab., Ill.). pp B8.6.1-11 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

A considerable amount of conflicting and insufficiently explained data on the incipient boiling superheat of the liquid alkali metals have been presented. Many parameters have been shown or postulated to affect the nucleation conditions. It is demonstrated that several of these parameters are interrelated. Experimental support of this nucleation model is presented in which the importance of the pre-boiling system history and inert gas effects in pool boiling is clearly shown. These two effects account for the observation of several other apparent effects, e.g., heat flux. The essential information that must be used to characterize liquid metal incipient boiling experiments is identified. (auth)

9135 CONDENSATION OF A HIGH VELOCITY VAPOR ON A SUBCOOLED LIQUID JET IN STRATIFIED FLOW. Linehan, J. H. (Marquette Univ., Milwaukee); Grolmes, M. A. pp Cs2.6.1-10 of Heat Transfer 1970. Vol. VI. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

An analysis of high-velocity condensing vapor flowing concurrently with a subcooled liquid jet in a variable cross section duct is presented. From a model describing the interphase energy exchange mechanism in analogy with Prandtl mixing length theory for free turbulent jets, it is concluded that the liquid jet Stanton number is equal to a single empirically determined constant. The vapor-liquid interfacial shear stress is determined from a model which considers the effect of mass transfer at the interface. Predictions of axial pressure profiles calculated from the governing equations are compared with available experimental pressure profiles for convergent and constant area condensing test sections. (auth)

9136 EXPERIMENTAL STUDY OF ENERGY TRANSFER PROCESSES RELEVANT TO THERMAL EXPLOSIONS. Board, S. J.; Clare, A. J.; Duffey, R. B.; Hall, R. S.; Poole, D. H. (Central Electricity Generating Board, Berkeley, Eng.). Int. J. Heat Mass Transfer; 14: No. 10, 1631-41(Oct 1971).

Energy transfer and vapor production processes were studied in an experiment involving the transient heating of a metal foil under water. Data were obtained on temperature, pressure and heat flux with a time resolution of ≤10 μs over the range of foil temperatures 100 to 900°C and of water subcoolings 20 to 80°C. Both unstable and stable energy transfer processes were shown to occur at temperatures above the nucleate boiling region and relevant quantitative heat flux data were obtained. (auth)

9137 GENERAL TECHNIQUE FOR THE PREDICTION OF VOID DISTRIBUTIONS IN NON-STEADY TWO-PHASE FORCED CONVECTION. Hancox, W. T. (Canadian Westinghouse Co. Ltd., Hamilton, Ont.); Nicoll, W. B. Int. J. Heat Mass Transfer; 14: No. 9, 1377-94(Sep 1971).

An analytical technique is presented for the prediction of non-steady void and enthalpy distributions in forced convection flow-boiling water. The analysis is based on the cross section averaged form of the mass and energy conservation equations. Auxiliary relations, based on a local condition hypothesis, are developed to describe the effect of non-uniform void and velocity profiles and the vapor generation rate. Predictions of steady flow axial void distributions are shown to be in good agreement with the available data, as are predictions of void oscillation amplitude and phase lag for modulated heat flux data. (auth)

9138 DISPERSED FLOW FILM BOILING OF NITROGEN WITH SWIRL FLOW. Bergles, A. E. (Georgia Inst. of Tech., Atlanta); Fuller, W. D.; Hynek, S. J. Int. J. Heat Mass Transfer; 14: No. 9, 343-54(Sep 1971).

The heat-transfer characteristics of two-phase film boiling of nitrogen in tubes with tape-generated swirl flow are described. The swirl flow substantially augments the heat transfer and minimizes the thermal non-equilibrium, which is responsible for the relatively poor performance of boilers without twisted-tape inserts. Assuming thermal equilibrium, it is possible to formulate a relatively simple super-position correlation for both evaporation and superheat regions of the once-through boiler. The correlation gives good prediction of wall temperatures along the tube for the entire range of test conditions. (auth)

9139 RAPID GROWTH OF A VAPOUR BUBBLE AT A LIQUID–SOLID INTERFACE. Van Ouwerkerk, H. J. (Koninklijke/Shell-Laboratorium, Amsterdam). Int. J. Heat Mass Transfer; 14: No. 9, 1415-31(Sep 1971).

The rapid growth of vapor bubbles at a liquid–solid interface, as in boiling liquids, is described by a self-similar solution. A bubble grows as a hemisphere, the square of the radius increasing proportionally with time, while a thin layer of liquid is left on the solid under the bubble. Evaporation from this layer contributes to the growth rate and creates a dry area at its center. The theory is illustrated with some experimental results. An analysis is presented of the boundary layer on the solid surface outside the bubble. It is shown that separation of this boundary layer does not occur, which explains the presence of the microlayer. (auth)

9140 CALCULATION OF TURBULENT VELOCITY DISTRIBUTION AND WALL SHEAR STRESS IN ECCENTRIC ANNULI. Eifler, W.; Nijsing, R. (EURATOM–CCR, Ispra, Italy). Atomkernenergie; 18: No. 2, 133-42(1971). (In German).

A method is described which makes it possible to calculate the detailed turbulent velocity distribution in finite arrays of parallel rods. In the description of momentum transport account is taken of both turbulent diffusion and secondary flow. As an example, the case of turbulent flow in eccentric annuli is treated. The expressions for the turbulent transport properties are those obtained for the infinite rod array. The agreement between theoretical predictions and experimental results of Tiedt and Jonsson is quite satisfactory. (auth)

9141 CONDUCTIVITY EFFECTS ON RIBBED SURFACE HEAT TRANSFER. Mantle, P. L.; Freeman, A. R.; Watts, J. (Central Electricity Generating Board, Gloucestershire, Eng.). Int. J. Heat Mass Transfer; 14: No. 11, 1825-34(Nov 1971).

A study was made of heat-transfer from rib-roughened surfaces, in particular AGR fuel elements and the electrically heated scaled-up dummy elements used in establishing their performance in the laboratory. It is shown that important corrections have to be made for the conductivity of the test element and coolant gas. Computed temperature distributions within ribbed surfaces are correlated in such a way that an allowance for surface heat-transfer efficiency

(E_{∞}) can be predicted for different operating conditions. The laboratory heat-transfer measurements have to be reduced by typically 8% to give performance information appropriate to reactor conditions. The principles should be applied to any heat-transfer surface when interpreting experimental results and comparing data. (auth)

9142 HEATED LAMINAR GAS FLOW IN ANNULI WITH TEMPERATURE-DEPENDENT TRANSPORT PROPERTIES. Shumway, R. W. (Idaho Nuclear Corp., Idaho Falls); McEligot, D. M. Nucl. Sci. Eng.; 46: No. 3, 394-407(Dec 1971).

Numerical results for laminar gas flow in annuli, with fluid properties varying due to their temperature dependence, have been obtained for both fully developed and uniform entry velocity profiles by solving the coupled boundary layer equations in finite difference form. All annuli computations were made with a radius ratio of 0.25, which differs sufficiently from the limiting cases of circular tubes and parallel plates to portray annular geometry well. In addition to variable property results, predictions were obtained for three of four fundamental, constant property solutions with uniform entering velocity profiles. The fourth solution is available in the literature but the approximate velocity distribution is in error in the entrance region, so a new hydrodynamic solution is presented as well. (auth)

9143 PROPAGATION OF PRESSURE WAVE IN AIR-WATER TWO-PHASE SYSTEM. I. Miyazaki, Keiji; Fujii-e, Yoichi; Suita, Tokuo (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 606-13(Nov 1971).

In an attempt to gain information on the propagation characteristics of pressure waves in a two-phase system consisting of gas and liquid, experiments were performed on a nonflowing air–water mixture in a range of pressures from 1.0 to 7.5 bar and void fractions from 0 to 60%. Stepwise pressure disturbances were applied to a water column dispersed with rising air bubbles by bursting diaphragm. The pressure transients at several points down the fluid column were measured with strain gage-type pressure transducers and recorded on magnetic tapes. The nonlinearity of the pressure wave records was scarcely marked. The propagation velocity of pressure wave front down the fluid column was found almost independent of the magnitude of the pressure change applied, nor whether it was depressive or compressive. At higher void fractions where the flow regime became sluggy, the measured propagation velocities showed increasing deviation from the calculated values based on the nonslip homogeneous adiabatic model, though good agreements were obtained at lower void fractions of bubbly regime. Evidence was offered in disproof of the effect of heterogeneity due to slug regime as the preliminary step to attribute this discrepancy to the effect of slip. (auth)

9144 OPTICAL PROBE FOR MEASURING THE LOCAL VOIDAGE IN TWO-PHASE FLOW SYSTEMS. Danel, F.; Delhaye, J. M. (CEN, Grenoble, France). Mes., Regul., Automat.; 36: No. 8-9, 99-101(Aug-Sep 1971). (In French).

The principle of an optical probe is very straightforward; it is based on the total reflection phenomenon. An optical probe consisting of a low power (<1 W) lamp, a fiber optics with a sheath whose refractive index varies radially, and a phototransistor is presented. The end of the probe, that is, the sensitive part is obtained by bending the fiber through 180°, a diameter of 100 microns being achieved. The fiber is placed in a stainless steel tube thus assuring the rigidity of the assembly. The shape of the signal obtained for a water–air flow with bubbles system corresponds to the signal obtained with an anemometric type probe. In a two phase conducting media the optical probe eliminates the electrical difficulties encountered with variable impedance probes. Its reduced dimensions allow the metrology of small bubble flows, met in critical two-phase flow systems or in emulsion flow, to be overcome. (France)

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Refer also to abstracts 8675, 9221, 9260, 9308, 9837, and 9854.

9145 (BNWL-1308-7) PACIFIC NORTHWEST LABORATORY DIVISION OF ISOTOPES DEVELOPMENT PROGRAMS. QUARTERLY REPORT, MAY–JULY 1971. Hansen, J. E. (comp.) (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1971. Contract AT(45-1)-1830. 46p. Dep. NTIS.

Activities in a program to develop inexpensive Cs and Sr sources using Hanford waste are summarized. Research on the radiation characteristics of fission-product ^{107}Pd is reported along with an evaluation of applications for fission-product Xe. Work devoted to methods for reducing the ^{148}Pm content in Pm heat sources is described along with work directed to measurement of radiation doses and biological effects of radioisotopic heat sources for circulatory support systems. Research on development of low-flux imaging in neutron radiography using ^{252}Cf is reported along with work on evaluation of thin-film encapsulation of ^{241}Am alpha photon sources. Development of neutron techniques for seabed mineral exploration using ^{252}Cf neutron sources is described. (J.R.D.)

9146 (BNWL-SA-4108) AVAILABILITY AND APPLICATIONS OF RADIOACTIVE AND STABLE BY-PRODUCTS FROM THE CHEMICAL PROCESSING OF SPENT NUCLEAR POWER FUELS. Rohrmann, C. A. (Battelle Pacific Northwest Labs., Richland, Wash.). [1971]. Contract AT(45-1)-1830. 24p. (CONF-711121-1). Dep. NTIS.

From tenth Japan conference on radioisotopes; Tokyo, Japan (16 Nov 1971).

Radioactive and stable by-products from the chemical processing of spent nuclear fuels which are useful due to unique properties; more economically produced by this method than by any other method; needed for particular application; and present in sufficient quantities to warrant recovery, are identified and their characteristics, availability, and uses discussed. Predictions are made on the future use of the following unusual materials produced as nuclear fuel processing by-products: Np, Sr, Xe, Cs, Pm, Rh—Pd, Kr, Am–Cm, Ru, Tc, and Ce (listed in descending order of probable use). (L.C.L.)

9147 (JPRS-54454) TRANSLATIONS ON EASTERN EUROPE. Scientific Affairs No. 204. Translation of articles on Eastern Europe. 38p. NTIS.

Information is presented on: the production, testing, and uses of sealed radioisotope sources in East Germany; the development of radiation technology in East Germany using isotope sources; and geodetic surveying activities in Romania. (L.C.L.)

9148 (KFK-1437) SEPARATION OF UF_6 AND ADMIXTURE GAS AT A SEPARATION NOZZLE FACILITY WITH A COMBINATION OF PRELIMINARY FILTER-SEPARATION NOZZLE AND LOW TEMPERATURE FINE SEPARATION. Fritsch, H. J.; Schuette, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Jul 1971. 79p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted by H. J. Fritsch to Technische Hochschule, Karlsruhe, Ger.

In separation nozzle cascades using as process gas a mixture of uranium hexafluoride (UF_6) with a light admixture gas it is necessary to discharge the net transport of the pure admixture gas at the top and the upper shoulder of the cascade and feed it back to the bottom of the corresponding section of the cascade. For this purpose, a combination of a separation nozzle stage for crude purification and a subsequent low temperature separation plant, in which the residual UF_6 is frozen out of the admixture gas, was chosen as an economical process. The layout of the plant was optimized with regard to the costs of its components. The most economical way of operating the nozzle stage for separating gas mixtures, particularly H_2/UF_6 mixtures, was found out by means of experiments. The course of UF_6 condensation (desublimation) in the freeze-out heat exchanger was calculated by computing the "cooling curve" step by step. As a result of pre-optimization of the geometry of the extended surface compact heat exchanger used as a freeze-out exchanger, the supersaturation rates of the UF_6 obtained along the exchanger in the course of the freeze-out period were found out to be below 20, although the H_2/UF_6-mixture has a Lewis number of 2 + 4 in the interesting ranges of temperature and concentration. It seems to be necessary to avoid condensation of the UF_6 within the bulk of the gas flow since, for economical operation of the separation nozzle plant, a UF_6 concentration should be reached in the purified admixture gas that is on the order of 1 ppM. With the costs optimized, the operating conditions both of the nozzle stage and of the low temperature separation plant as well as the lay-out variables of their components were optimized by means of a total variation of the parameters. The pre-separation nozzle stage in the most economical H_2/UF_6 separation plant immediately feeds back into the cascade 80% of the UF_6 to be separated. This plant requires no intermediate compressor for the pressure rise in the low temperature unit. At an operating pressure of 170 torr and a lowest temperature of 160°K, a UF_6 concentration of 0.1 ppM was obtained there within the purified hydrogen. The total cost of the separation system amounts to about 2% of the separative work unit costs in the cascade. Further optimization, which was carried out for control purposes, resulted in H_2/UF_6 separation costs about 50% higher than those of the combined process at its optimum. (auth)

9149 (LA-4819) QUARTERLY STATUS REPORT ON ^{238}Pu SPACE ELECTRIC POWER FUEL DEVELOPMENT PROGRAM,

JANUARY 1–MARCH 31, 1971. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 16p. Dep. NTIS.

Activities in programs to characterize PuO–Mo cermets (PMC) were continued. Information is included on preparation of feed powder, properties of PMC, and preparation of $^{238}PuO_2$ powder. (J.R.D.)

9150 (MLM–1809) METALLOGRAPHIC ANALYSIS OF DART II HEAT SOURCE CAPSULE. Fitzharris, R. E.; Kelly, M. D.; Selle, J. E. (Mound Lab., Miamisburg, Ohio). 17 Sep 1971. Contract AT(33-1)-Gen-53. 33p. Dep. NTIS.

A complete metallographic analysis of the DART II heat source capsule was performed. The purpose of the analysis was to determine the extent of any reaction between various components of the capsule. The diffusion of the fuel into the liner interface reached a maximum of 90 μm. The impurities in the fuel diffused into the liner to form intermetallic compounds. An increase in hardness of the tantalum-10% tungsten resulted from absorption of oxygen released from the decomposition of the fuel. (auth)

9151 APPLICATION OF TRANSURANIUM AND TRANSPLUTONIUM ELEMENTS. Kobayashi, Masatoshi (Japan Atomic Energy Research Inst., Oarai). Genshiryoku Kogyo; 17: No. 7, 21-5(Jul 1971). (In Japanese).

A review is given on the history of transuranium and transplutonium elements and the use of these elements as energy sources and neutron sources in the treatment of cancer, neutron radiography, activation analysis, γ capture analysis, and in nuclear fuels. An example of the use is in cardiac pacemakers. Electric cells used for the pacemakers must be very small, long-lived, and lightweight. In the USA, a cell with 300 mg ^{238}Pu was made, and in France, a pacemaker was completed, electric power supply of which is 200 μW. The dimension is 65 mm in diameter and 28 mm long and 200 g in weight. 150 mg of ^{238}Pu is used for the pacemaker. According to plan by the U. S. Atomic Energy Commission, annual production of ^{238}Pu is expected to be 200 kg in 1975 and 500 kg in 1980. ^{239}Pu and ^{244}Cm are useful for use in radioactive generators. The generators were used in Surveyor space ship. (Japan)

9152 NEEDLES OF YTTRIUM OXIDE CONTAINING ^{90}Y FOR MEDICAL PURPOSES AND FAST MEASUREMENT OF THEIR ACTIVITY. Mikhailov, M. I.; Mazhkarov, S.; Nikolov, K. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 223-8(1971). (In Bulgarian).

A method for preparing yttrium needles with a diameter of 1 mm and length of 2 to 5 mm was found. The rapid measurement of their high total activity is accomplished with a view of their quick preparation for medical purposes. In order to prepare yttrium needles that are homogeneous, compact and sufficiently sound, a suitable binding material was found. To this end a special device was constructed. After the necessary thermal processing the needles preserve their shapes and sizes and acquire the brightness of a ceramic article. They are made from spectrally pure yttrium oxide and, for all practical purposes, do not contain radioactive contaminants. After their activation and sterilization, they are not destroyed. They do not disintegrate when in the tissue where they are introduced. The measurement of the total activity is accomplished by a 4π spherical ionization chamber. The regular measurement of the activity required the preliminary investigation of the self-absorption effect. The activity of 30 to 40 needles per hour can be determined. (auth)

9153 COMPARISON OF RADIOISOTOPE-FUELED ENERGY SOURCES FOR A PROSTHETIC DEVICE. Hixson, Joel D. (Medtronic, Inc., Minneapolis). Isotop. Radiat. Technol.; 9: No. 2, 215-22(Winter 1971-1972).

Cardiac pacemakers fueled with ^{147}Pm and ^{238}Pu and using thermoelectric, thermionic, and betavoltaic energy conversion are compared. (auth)

9154 ^{60}Co USE IN THERMOELECTRIC GENERATORS. Isotop. Radiat. Technol.; 9: No. 2, 230-4(Winter 1971-1972).

The advantages of ^{60}Co as a heat source for use in thermoelectric generators are discussed, and several conceptual and prototype designs are described. (auth)

9155 ISOTOPE ENCAPSULATION BY ELECTRON BEAM WELDING. Boolen, R. F. (Battelle-Northwest, Richland, Wash.). pp 313-68 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

Promethium-147, plutonium-239, and americium-241 were encapsulated. Both low and high power density electron beams, with open handling techniques heretofore thought too hazardous to be used, were employed to encapsulate certain of these radioisotopes, mainly in refractory metal claddings. A successful method of encapsulating these highly toxic alpha and beta emitters without excessive contamination of electron-beam equipment was found. The seriousness of low-level contamination, which is inevitable on primary welds, within the welder, depends upon the type of welder used. It was found that radioisotope contamination in high-voltage machines did not reach the light optics or gun, allowing normal maintenance and adjustment of these parts. Leak testing of capsules was done through the use of helium mass spectrometers and certain back pressurizing techniques were used to insure the validity of the method. The use of a number of different metals and alloys was investigated. Electron beam test welds were made for each cladding material and these were evaluated through metallographic techniques. A heat source of promethium-147 was incorporated in the Radioisojet (microthruster) for the AEC and NASA. The critical welds were made by electron beam. Radiation sources made of promethium-147 were encapsulated for use in In-Phantom Dosimetry studies. Many promethium-147 capsules were constructed for compatibility tests of cladding and core. A heat source made up with promethium-147 as the fuel was used as a thermal preconditioner for the Advanced Manned Strategic Aircraft (AMSA) test program. Future work in encapsulation of heat and radiation sources is discussed, and equipment which may be used in the future is described. (TSS)

9156 APPLICATION OF ISOTOPES PRODUCED BY NUCLEAR FISSION. Enomoto, Shigemasa (Japan Atomic Energy Research Inst., Oarai). Genshiryoku Kogyo; 17: No. 7, 16-20 (Jul 1971). (In Japanese).

A review is presented of the history of fission products, use of spent nuclear fuel and mixed fission products (MFP), industrial and medical irradiation equipment using ^{137}Cs, β sources for irradiation, luminescent paints and self-luminous lamps, sealing testers, and recovery of precious metals. Important fission products are ^{85}Kr, ^{90}Sr, ^{99}Tc, Rh, ^{106}Ru, Pd, Xe, ^{137}Cs, ^{144}Ce, and ^{147}Pm. These are useful as the β sources, β–x-ray sources, special lamps, various tracers, heat sources, electric power generators, inhibitors of corrosion, additives for alloys, semiconductors, decorations, various electric instruments, and γ sources. Some fission products are concentrated to increase their radioactivity and are used as mixed fission products. Cesium-137 is used for treatment of cancer in place of radium. For leak testing, equipment to be examined is filled with gaseous radioisotopes and leakage of the gases is detected by radioactivity. A mixture of N_2 and ^{85}Kr is often used for this purpose. (Japan)

9157 PHYSICAL PRINCIPLES OF ^{235}U ENRICHMENT ACCORDING TO THE SEPARATION NOZZLE METHOD. THE EFFECTS OF ADDED LIGHT GASES. Becker, E. W.; Bier, W.; Ehrfeld, W.; Eisenbeiss, G. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch.; 26a: No. 9, 1377-84(Sep 1971). (In German).

The separation nozzle process for enrichment of ^{235}U is based on the mass-dependent centrifugal force generated in a curved flow of a UF_6/He or UF_6/H_2 mixture. It is shown that the experimentally determined separation effects can exceed those calculated for equilibrium separation in a stream flowing with an infinite velocity. A numerical analysis of the ternary diffusion process indicates that the separation of the UF_6 isotopes is improved by the fact that the added light gas prevents the UF_6 from concentrating rapidly at the boundary of the centrifugal field. (auth)

9158 INDUSTRIAL PRODUCTION OF HEAVY WATER. Kortus, Josef (Chemoprojekt, Prague); Zoch, Oldrich. Jad. Energ.; 17: No. 9, 291-6(Sep 1971). (In Czech).

The current methods of production of heavy water are critically reviewed and the difficulties encountered in constructing new plants are discussed. The possibility of manufacturing heavy water in the Czech SSR has been studied using H_2S and isotopic exchange as a basis for evaluating two possible production technologies. Evaluation of both technical and economic problems is performed. (tr-auth)

9159 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V SUDOVOM MASHINOSTROENII. (Use of Radioactive Isotopes in the Construction of Marine Equipment). Lakhanin, V. V. Leningrad; Izdatel'stvo Sudostroenie (1971). 176p.

The application of radionuclides to the problems of control and measurement in the shipbuilding industry is considered. Defectoscopes and apparatus for determining density and chemical composition of material, thickness of machine parts, and coatings are explained. Protection from radiation and dosimetric control equipment are discussed, with special reference to organization of work in a radioisotope laboratory. (K.S.W.)

9160 DEVELOPMENT OF A PLASMATRON ION SOURCE FOR AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Winter, H. (Technische Hochschule, Vienna). J. Mass Spectrom. Ion Phys.; 6: No. 5-6, 393-400(Jun 1971).

A Plasmatron ion source with slit geometry for the Seibersdorf electromagnetic isotope separator was developed; in its present state this ion source delivers well-focused noble gas ion beams in the mA range at the collector. The influence of the various parameters of this special ion source on the properties of the extracted ion beam is discussed, and a comparison with a simple extraction process model is made. (auth)

9161 PREPARATION OF THIN SOURCES BY MEANS OF ELECTROSTATICALLY DEFLECTED AND DECELERATED IONS INSIDE AN ISOTOPE SEPARATOR. Tortschanoff, T.; Viehboeck, F. P. (Reactor Centre, Seibersdorf, Austria. Technical Univ. of Vienna). J. Mass Spectrom. Ion Phys.; 6: No. 5-6, 427-34(Jun 1971).

To prevent sputtering damage and quality reduction caused by penetration effects, it is not sufficient to decelerate the ions when preparing monoisotopic β sources inside an electromagnetic separator. Energetic neutral beam particles also give rise to these effects, which disturb the collection efficiency. A simple collector arrangement was set up, in which the ion beam is deflected through approximately 30° before being decelerated. For this collector system potential distributions and typical ion paths were computed. The calculations are compared to experimental results. For a typical case of isotope separation the abundance of the neutral particles reaching the collector was investigated. (auth)

9162 NUCLEAR SCALES FOR WEIGHING CLINKER ON A PLATE CONVEYOR. Scharf, Waldemar (Polytechnic, Warsaw). Nukleonika; 16: No. 5-6, 231-42(1971). (In Polish).

The principle of radiometric continuous weighing of clinker on a plate conveyor is described. The principle of the scales operation is based on the measurement of ^{60}Co gamma radiation, scattered from the material weighed. (auth)

9163 RADIOISOTOPE THERMOELECTRIC GENERATOR. Barker, Theodore R.; Kershaw, Wilfred L.; Stivers, George S.; Thomas, Jack L. (to Teledyne, Inc.). U. S. Patent 3,615,869. 26 Oct 1971. Filed 26 Jul 1965.

An improved thermoelectric generator assembly is described including a heat sink member adapted to dissipate heat directly to the environment and having a thermoelectric conversion system removably connected thereto utilizing a thin cover having bellows-type sidewalls. The thermoelectric elements are positioned within perforations formed in a platelike insulating disk. The heat sink member is removably connected to a cylindrical container, which may be cup shaped, and which is formed of a radiation shielding material. A shielded radioisotopic fuel capsule is positioned within the container and separated therefrom by thermal insulation in solid configuration retaining form. (Official Gazette)

9164 WELL LOGGING WITH ^{252}Cf. Keys, W. Scott; Boulogne, A. R. Log Anal.; 10: No. 6, 11-24(1969).

Californium-252, an isotopic neutron source only recently available for experimental well logging, has 300 times the emission rate of any other one-curie radioisotopic source. It also has small physical size, low gamma and heat emission, and expected relative low cost. The nuclear and physical characteristics of a fabricated 50-millicurie ^{252}Cf source and some of the health physics aspects of its use are discussed. Used to make epithermal neutron logs, which are compared with logs made with plutonium–beryllium and americum–beryllium sources in the same well, the high neutron flux from ^{252}Cf permitted longer than usual spacing while maintaining a high count rate and excellent sensitivity. In addition, continuous activation logs were made using a spacing of 5.5 feet from source to detector. This new technique may provide a log more closely related to clay content than the natural gamma log. (Geophys. Abstr.)

9165 MEASURING WIDTH VARIATIONS OF A MOVING SHEET BY THE USE OF BETA-RAYS. Platzek, Paul; van Kempen, Gerardus; Ros, Dominicus (to Nederlandse Organisatie Voor Toegepast-Natuurweten-Schappelijk Onderzoek Ten Behoeve van Nijverheid). U. S. Patent 3,614,445. 19 Oct 1971. Priority date 3 Jun 1966, Netherlands.

A device is described for measuring the variation in width of a moving sheet of material comprising two substantially identical sources of β particles positioned above the edges of the sheet and preferably one elongated ionization chamber positioned below the sheet. An electrical scheme is shown which comprises a differential amplifier. (Official Gazette)

9166 URANIUM ENRICHMENT PRICING CRITERIA. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, FEBRUARY 25, 1971. Washington, D. C.: Joint Committee on Atomic Energy (1971). 135p. GPO 0.60.

On February 25, 1971 the Joint Committee on Atomic Energy held hearings on the AEC's proposed increase in the price of uranium enrichment services and new criteria for pricing. The statements of witnesses before the committee are reported verbatim. Additional material submitted for the record included AEC answers to JCAE questions on uranium enrichment prices and pricing criteria and statements by Commissioner Ramey, Congressman C. Holifield, and S. M. Stoller. Correspondence and nine appendixes of published information pertinent to the subject are included. (L.C.L.)

9167 GUIDE ON RADIATION SAFETY CONSIDERATIONS IN THE PREPARATION OF LICENSE APPLICATIONS. AEC Licensing Guide 1970. Washington, D. C.; Atomic Energy Commission (1970). 34p. Available from Government Printing Office, Washington, D. C.

Information is presented which is intended to provide general guidance to persons wishing to apply for an AEC license authorizing the use of sealed radioactive sources in industrial radiography. AEC regulations which apply to radiography and which should be used in conjunction with this guide are listed. Information is included on: radiography personnel and required qualifications; training program; the limited radiography license; operating and emergency procedures; internal inspection system; organization of the radiography program; leak testing; and radiographic operations in Agreement States. (L.C.L.)

9168 CERTIFICATION OF CLASS I STANDARD SPECTROMETRIC GAMMA SOURCES. Konstantinov, A. A.; Anufriev, S. N. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 2, 297-300 (Feb 1971).

Translated from Izmer. Tekh.; 14: No. 2, 77-80(Feb 1971).

High accuracy can be obtained with the relative method of determining γ-radiation activity using a scintillation counter only when the samples are precisely positioned, especially for small distances between the source and the radiation detector. Because of the low levels of activity of the standards (approximately 0.5 μCi), standard spectrometric gamma sources must be calibrated for small distances between the source and the detector. Additional measurements taken with the source rotated through 180 greatly reduce the systematic error caused by inaccurate positioning. A large scintillation crystal of NaI(Tl) used as a detector reduces systematic error in relative measurements owing to the sources shifting from the detector axis and to variations in the dimensions of the radioactive spots of different sources. (auth)

9169 RADIOISOTOPE-FUELED STIRLING ENGINE ARTIFICIAL HEART SYSTEM. Martini, W. R. (McDonnell Douglas Astronautics Co., Richland, Wash.); Riggle, P.; Harmison, L. T. Nucl. Technol.; 13: No. 2, 194-208(Feb 1972).

Steady improvements have been made through five systems for operating an artificial heart with a Stirling engine that will be heated by a radioisotope or by an electric heater which receives power from a transcutaneous transformer. A thermal storage reservoir assists in supplying peak power demands. The engine regenerator, a primary component, was substantially improved by changing from a porous to a hollow regenerator. Engine efficiency was doubled. The current engine, using a hot flexural support at the engine, a bellows-sealed lower support, a drive piston, and a flywheel for continuity of regenerator motion, has been quite successful. Potential reductions in size and isotope requirement are discussed. The computed dose rate for the system is also given. Development is continuing toward a reliable realistically sized artificial heart with reasonable power demands. (auth)

9170 DOSE RATIO OF SCATTERED PHOTONS TO THE INCIDENT BEAM IN STANDARD ^{60}Co MULTICURIE GAMMA RAY SOURCE. Nishijima, Toshiji; Hosokawa, Nobuhisa; Takebe, Masahiro. Denki Shikensho Iho; 35: No. 4, 394-405(1971). (In Japanese).

In the standard dose measurements the dose rate deviates according to the position of the source even when the distance between the source and the detector is kept constant. It is assumed to be affected by scattered photons from both the lead container and air. In order to confirm it the dose ratio of scattered photons to the incident beam has been calculated according to the Klein-Nishina formula, using a FACOM 230-50 electronic computer. The calculation shows that the dose rate of scattered photons from air is very small compared with the one from the lead container, and

that the total scattered dose rate reaches 11% of the incident dose rate at a proper source position. (auth)

Materials Testing

Refer also to abstracts 9167, 9310, 9370, 9411, 9687, 9858, and 9931.

9171 (ANL–7801) SEMIAUTOMATIC APPARATUS FOR CREEP AND STRESS-RUPTURE TESTS OF THIN-WALL FUEL-CLADDING TUBES UNDER INTERNAL GAS-PRESSURE LOADING. Yaggee, F. L.; Styles, J. W.; Brak, S. B. (Argonne National Lab., Ill.). Sep 1971. Contract W-31-109-eng-38. 26p. Dep. NTIS.

A semiautomatic apparatus is described for creep and stress-rupture tests of small-diameter, thin-wall tubes under biaxial load. Twenty-four specimens, arranged in four bundles each with six specimens, are accommodated in a single test. Each bundle is connected to a common source of high-pressure gas. Creep or stress-rupture tests can be conducted under constant-load (constant-pressure) or constant-stress (decreasing-pressure) conditions at temperatures to 1200°C in a vacuum or an inert-gas environment. Biaxial creep tests were conducted on Types 304 and 304L stainless steel tubes at temperatures between 550 and 700°C and applied tangential stresses between 7500 and 40,000 psi. Test results have yielded a value of 6.7 for the stress dependence of the steady-state creep rate and 95,000 cal/mole for the activation energy of creep. Both values are in good agreement with the published values for 18-8 austenitic stainless steel determined in uniaxial creep tests. Experimental results provide a strain profile of the three types of specimen failures normally observed: catastrophic rupture, pinhole leak, and fissure. The results also yield information on the change in material density as a function of diametral strain, strain rate, and temperature. (auth)

9172 (BNWL-SA–2697) NONDESTRUCTIVE EVALUATION OF CLADDING COLD WORK AND GRAIN SIZE. Becker, F. L.; Trantow, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 8 Dec 1969. Contract AT(45-1)-1830. 4p. (CONF-691133–1). Dep. NTIS.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

A method for nondestructively measuring the extent of cold work in Type 316 stainless steel fuel cladding is described. The method involves the use of ultrasonic critical angle reflectivity, is independent of dimensional variations, and has a minimum areal resolution of 20 sq miles. (J.R.D.)

9173 (CONF-711114–1) NONDESTRUCTIVE TESTING OF IRRADIATED FUEL ELEMENTS IN THE U.S.A. McClung, R. W. (Oak Ridge National Lab., Tenn.). [nd]. 13p. Dep. NTIS.

From Meeting on NDT for reactor core components and pressure vessels; Vienna, Austria (29 Nov 1971).

Many nondestructive testing techniques are being used to examine fuel elements after irradiation. Penetrating radiation techniques include both neutron and x radiography. Ultrasonic techniques are used to inspect bonding and to detect flaws in cladding; eddy-current techniques are used to measure spacing between components, measure thickness, and detect flaws. A variety of mechanical devices are used to measure physical dimensions. (auth)

9174 (INIS-mf–64) DIAGRAMS EXPOSITION AND SENSIBILITY OF ZIRCALOY'S RADIOGRAPHY. Baez, J. N.; Roa, J. L. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 9p. (In Spanish). (CONF-701124–1). INIS.

From Metallurgical meeting; Cordoba, Argentina (Nov 1970).

The importance of exposure diagrams for the correct determination of the operational conditions of radiographic tests is well known. The Zircaloy-4 diagrams obtained with films of high and medium definition, using intensified sources, acceleration voltage between 100 and 300 kV, and Zircaloy thickness between 0.5 and 40 mm were reported. The intermediate diagrams obtained by the construction of exposure diagrams were presented and the results analyzed. The method used for obtaining the exposure diagrams make it possible to accumulate important data with respect to the radiographic examination. The type of diagram obtained makes it possible not only to determine the exposure times for the radiograph of a determined thickness but provides additional information with respect to the greater or less contrast obtainable with different acceleration voltages. As the x-ray spectrum with which a radiographic examination is conducted is of great importance to the sensitivity of the contrast, the realization of these exposure diagrams are of interest for the verification of the hardness of the radiation of an x-ray machine in intensive use for a long period of time. In these cases the new exposure diagrams make it possible to adjust the test conditions. (INIS)

9175 (RCN–138) NEUTRON RADIOGRAPHY: A SUMMARY OF PRINCIPLES AND POSSIBILITIES. de Munk, P. J. (Reactor Centrum Nederland, Petten). May 1971. 32p. Dep. NTIS (U. S. Sales Only).

The theory and practice of neutron radiography is described. Most attention is paid to that technique by which radiographs of radioactive materials can be made. This technique is called the transfer method which uses an intermediate radioactive foil to produce an image on a photographic film. Neutron radiography is proposed to be applied as a nondestructive inspection method especially for the examination of irradiated fuel, although other experiments may benefit by using this inspection technique. A few experiments were and are being conducted in a beam tube of the Low Flux Reactor. The aim of these experiments is to provide data for the apparatus that will be installed in the HFR. (Netherlands)

9176 EXTENSIVE INTRODUCTION OF NONDESTRUCTIVE INSPECTION: AN IMPORTANT METHOD OF INCREASING PRODUCTION QUALITY. Balashov, V. P.; Dubitskii, L. G.; Stretenskii, V. N. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 6, 838–49(Jun 1971).

Translated from Izmer. Tekh.; 14: No. 6, 21–31(Jun 1971).

The use of a programmed method and a systems approach to the treatment of the problem of increased product quality reveals that it is necessary to introduce systems for ensuring the detection of defects which are based upon the solutions of a broad range of scientific-technical and organization problems. Among the problems are standardization, unification, and the metrological security of the defect-detection facilities which are being created in the interests of all branches of the national economy and of science. (auth)

9177 NONDESTRUCTIVE TESTING OF NUCLEAR CERAMIC MATERIALS. McClung, R. W. (Oak Ridge National Lab., Tenn.). Amer. Ceram. Soc. Bull.; 49: 777–81(Sep 1970).

Nondestructive testing techniques can be used as aids to the ceramist and developer of fuel elements for the evaluation of properties of uranium, thorium, and plutonium compounds and components. Ultrasonic and eddy current techniques were used for measurement of physical properties of polycrystalline specimens. After formation into microspheres, microradiography was used as an aid to product development, process control, product acceptance, and postoperation evaluation. Measurements of radiation attenuation are useful as a monitor for in-line control for coating of the process particles. After assembly into spheres, infrared techniques can detect the nonbond between the fueled core and unfueled shell, and eddy current techniques detect the presence of flaws in the shell. After assembly into graphite-bonded fuel sticks or metal-clad fuel rods, qualitative imaging by radiography and quantitative measurement of radiation attenuation are useful for determination of variation in fuel content. (auth)

9178 CONTACT MICRORADIOGRAPHIC INSPECTION OF COATED NUCLEAR FUEL PARTICLES. Rooney, J. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Non-Destruct. Test.; 4: No. 5, 338–43(Oct 1971).

The application of microradiographic techniques to the examination of coated nuclear fuel particles and the development of two separate methods are described. The first method uses commercial x-ray film and gives a high contrast image of limited definition by which large numbers of particles may be inspected. The second method uses high resolution scientific plates giving a low contrast image of very high definition but it has the disadvantage that the plates require a long exposure. (auth)

9179 USE OF HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY FOR DETECTING FAILURE OF CLADDING IN ENCAPSULATED FAST REACTOR FUEL PINS. Phillips, J. R.; Schulte, J. W.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). pp 176–80 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A nondestructive technique utilizing precision gamma-ray scanning has been developed for detecting fuel cladding failure in doubly encapsulated fast reactor fuel elements. Detection of fission products, in particular ^{137}Cs, outside the fuel pin envelope was used to indicate the failure. The method was tested by examining

eleven mixed uranium–plutonium carbide and two mixed uranium–plutonium oxide fuel elements. Gamma-ray scanning indicated that six of the thirteen fuel elements had failed. These results were confirmed by mass spectrometric analysis of the gases in the outer encapsulation which were found to contain 11.7 to 65.0% xenon and 1.76 to 9.31% krypton. The cover gas from a seventh pin contained only 0.016% xenon and <0.003% krypton, and the presence of ^{137}Cs outside the cladding was not conclusively detected by gamma-ray scanning. Cesium-137 was not found in the outer encapsulation of the six other fuel elements by gamma-ray scanning, and mass spectrometric analyses confirmed that the cladding had not failed. (auth)

9180 RADIATION PENETRATION TEST AND ITS STANDARDS. Sena, Tomio (Osaka Univ., Suita, Japan). Keikinzoku Yosetsu; No. 99, 105-9(Mar 1971). (In Japanese).

For radiation penetration test, JIS Z 2341 (radiation penetration test method for metals) was established in 1955. Several JISs and NDISs (Japan Non-Destructive Testing Institute Standard) are established including test of fillet welds, pipe periphery butt welds, and x-ray equipment and photosensitive materials. Penetrameters and gradation gages are applied to indicate quality of images. In a few standards, correction of penetrameter discrimination is permitted when the absorption coefficient is different from wires of the penetrameter due to irradiated sample materials. There is growing tendency to adopt radiation quality gages for this problem. Since selection of testing method and determination of test conditions are generally important in nondestructive testing, qualification of test engineers is of great concern. Qualifying examinations of engineers have been performed by Japan Nondestructive Testing Institute. License with examination in accordance with JIS is also anticipated. These problems should also be discussed in relation to foreign standards. (Japan)

9181 METHOD FOR RADIOGRAPHIC EXAMINATION OF WELDED T-JOINTS IN A FLUE AND SMOKE-TUBE TYPE BOILER. Nohara, Ishimatsu (Ministry of Labour, Tokyo). Bull. JSME (Jap. Soc. Mech. Eng.); 14: No. 73, 694-703(Jul 1971).

If a shell or tube welded to a tube plate by T-(tee) joint, thermal stress will occur at the welded parts owing to the temperature difference between shell and tube. Therefore, welded parts should be inspected by radiographic examination. This is a difficult examination because of complexity of such a boiler. In order to establish an acceptable method of radiographic examination, test plates were made by the same welding procedure as applied for actual boilers, and the welded parts were examined radiographically under various conditions. The relationship between film exposure and thickness of welded part was studied to keep sufficient penetrant performance through the whole length of welded T-joint. (auth) (Japan)

9182 INSPECTION AND STANDARDS FOR STEEL MATERIALS FOR NUCLEAR MACHINERY AND EQUIPMENT. Sato, Kazuki (Mitsubishi Steel Mfg. Co. Ltd., Tokyo). Karyoku Hatsuden; 22: No. 2, 216-20(Feb 1971). (In Japanese).

With recent advances in nuclear power generation, demands are rising for establishment of manufacturing and inspection techniques and for the continuous supply of structural materials with stable properties. However, the standards and legal regulations have not been established. Mitsubishi Steel Mfg. Co. has engaged in the manufacture of reactor-grade steel for PWRs. Inspection and standards applied include those for materials, welding, quality control, and personnel. Standards are also included for inspection procedures for steel castings, such as nondestructive testing and affirmation of defect removal. Regulations applied for manufactured products include those for water chambers in steam generators, bent stainless steel pipes, stop valves, regulating valves, and turbine casings. (Japan)

9183 XERORADIOGRAPHY IN THE 1970's. McMaster, Robert C. (Ohio State Univ., Columbus); Hoyt, Hazen L. Mater. Eval.; 29: No. 12, 265-74(Dec 1971).

Xeroradiography, a unique imaging process which combines xerography with x-ray exposure, has been developed. This process was described in the ASNT Mehl Honor Lecture of 1950, and interest and active use of commerical manual systems continued in medicine and industry during the following decade. An automated xeroradiographic system is now being developed with improved performance capabilities which will be available for industrial usage during the decade of the 1970's. The new system consists of mechanized processes for conditioning and charging of x-ray-sensitive plates and for development, transfer and fixing of images. This equipment essentially automates plate handling through all steps of the xeroradiographic process with exception of the x-ray exposure, which remains wholly at the discretion of the operator. Manual handling of the photo-sensitive plates during processing is not necessary, since both plate charging and development take place automatically when the cassettes are inserted into the machines. Typical exposure techniques and xeroradiographs of industrial test objects are presented. (auth)

9184 NONDESTRUCTIVE TESTING LEADS THE WAY TO DENSE POWDER METAL PARTS. LoPilato, Salvatore A.; DeLai, A. Joseph (Avco Corp., Lowell, Mass.). Mater. Eval.; 29: No. 12, 275-80(Dec 1971).

Good use of nondestructive tests has been made to improve rocket nozzle inserts of copper-infiltrated tungsten powder. Such tests were employed for detecting density variation, finding local regions of anomalies which could result in laminar cracking, and determining the uniformity and completeness of copper infiltration (substandard conditions were subsequently corrected by adjustments in pressing and sintering procedures). A correlation between ultrasonic wave velocity and density of the porous tungsten billets was shown. A correlation between electrical conductivity (% IACS) of infiltrated parts and total strain-to-failure and between acoustic properties variability (i.e., velocity, flaws, and attenuation) and mechanical properties variability (i.e., modulus and ultimate strength), was developed. These correlations helped establish in-process and final inspection procedures for controlling quality of infiltrated parts. In short, judicious use of testing techniques developed in this program has helped to improve rocket nozzles considerably. (auth)

9185 CAPABILITY AND LIMITATION STUDY OF THERMOGRAPHY OF CARBON–CARBON CONES. Stiefeld, B.; Yoshimura, R. H. (Sandia Labs., Albuquerque, N. Mex.). Mater. Eval.; 29: No. 12, 281-7(Dec 1971).

A series of nondestructive tests utilizing a new thermal detector, known as a thermal transducer, and an infrared scanning camera has been conducted on a series of carbon–carbon test cones. The results of these tests compared with the results obtained using other NDT procedures. Recommendations regarding the capability of the thermal transducer are made, and unique methods of displaying data acquired by the infrared scanner are shown. (auth)

9186 AREA LOADING COMPRESSION TEST FIXTURE (4 Nov 1970) (Engineering Materials). (Bendix Aviation Corp. Research Labs., Detroit). (CAPE-2143).

7 drawings.

An air-bearing compression test fixture used with universal testing machines is described. The test fixture ensures parallelism of the test platens during load versus deflection testing of cellular silicone on RTV silicone foam cushions. Parallelism is maintained by guiding a moving ram through a bearing. The moving ram floats on an air cushion, which centers the ram in the guiding member, thus reducing frictional forces to zero. In testing and comparing this air-bearing fixture with a sleeve-bearing fixture, the air-bearing fixture showed a 21 to 42% improvement in standard deviation at the most meaningful test points. (For details see TID-4100, Suppl. 67) (F.S.)

9187 NONDESTRUCTIVE TESTING OF ELECTRICALLY CONDUCTING TUBES USING EDDY CURRENTS. Carossi, Jean Claude; Dufayet, Jean Pierre; Dujardin, Roger. (to Commissariat a l'Energie Atomique). French Patent 2,061,925. 1 Jun 1971. Filed 2 Oct 1969. (In French).

An improvement to nondestructive testing of electrically conducting tubes using eddy currents is described. The method is particularly suitable for investigating the characteristics of electrically conducting nonferromagnetic tubes and nuclear fuel pins. (France)

Protective Structures

9188 METHOD OF REMOTELY CONSTRUCTING A ROOM. Michie, Jarvis D.; De Hart, Robert C. (to United States Atomic Energy Commission). U. S. Patent 3,609,978. 5 Oct 1971. Filed 5 Jan 1970.

A method of constructing a room deep within the earth by personnel at the surface is described. A dual wall bladder of a watertight, pliable fabric material is lowered down a shaft into a selected position. The bladder is filled with a concrete grout while a heavy fluid having essentially the same density as the grout is maintained on both sides of the bladder to facilitate complete deployment of the bladder by the grout to form a room of desired configuration. (Official Gazette)

Radioactive Material Handling

Refer also to abstracts 8681, 8727, 9004, 9013–9015, 9090, 9429, 9430, 9543, 9558, and 9922.

9189 (AERE-R-6856) INERT ATMOSPHERE GLOVE BOX. Watson, P. G.; Rowlands, D. L. G. (Atomic Energy Research Establishment, Harwell (England)). Nov 1971. 16p. Dep. NTIS (U. S. Sales Only). UK 15p.

Various criteria which affect the performance of an inert atmosphere glove box are discussed. Factors covered include construction, safety, leak testing and gas purity, and are considered in relation to a project involving the handling of sodium metal and purified anhydrous salts. The appendices provide comparisons of the performance of various glove materials and instruments for monitoring impurities in inert gases. (auth)

9190 (JAERI-M-4497) GLOSSARY FOR NUCLEAR MATERIALS MANAGEMENT AND SAFEGUARDS. Kuriyama, Minoru; Ishihara, Takehiko (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 38p. (In Japanese).

The glossary (English-Japanese) has been prepared for nuclear materials management and safeguards, including the definition of terms, which is based on "Safeguards Glossary, WASH-1162, 1970." In the appendix are also given the Japanese-English index, classifications of the nuclear materials, the terminology in the Agreements between IAEA and the States, and UKAEA terminology. (auth)

9191 (ORNL-TM-3515) STATUS OF NOBLE GAS REMOVAL AND DISPOSAL. Nichols, J. P.; Binford, F. T. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 36p. Dep. NTIS.

Currently, noble gas fission products generated by the nuclear power industry are discharged to the atmosphere following interim holdup for decay of short-lived species. The resultant offsite radiation exposures have been small as compared with current guidelines for population exposure. Recovery of these gases will begin in the near future, however, as a result of stated policies of maintaining radioactive releases to the environment at the lowest practical levels. Several processes are available or under development for recovery of these gases from off-gas streams of nuclear reactors or fuel reprocessing plants. Processes that incorporate selective adsorption on low-temperature charcoal and cryogenic distillation have been demonstrated at the Idaho Chemical Processing Plant. A process utilizing selective absorption in fluorocarbons is undergoing engineering development at the Oak Ridge Gaseous Diffusion Plant. Initially, it is probable that the recovered noble fission product gases will be collected under high pressure in gas cylinders. These cylinders probably will be shipped to a large, remote site and stored under conditions that will promote long-term integrity of the cylinders. A longer-term possibility for encapsulation, which would tend to enhance containment during shipping and storage, is the sealing of gases as small bubbles or individual molecules within solids. Longer-term possibilities for storage include injection of the gases into deep underground formations. (auth)

9192 (Y-CDC-8) USE OF BOROSILICATE GLASS RASCHIG RINGS AS A NEUTRON ABSORBER IN SOLUTIONS OF FISSILE MATERIAL. Nichols, J. P.; Schuske, C. L.; Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 14 Jul 1971. Contract W-7405-eng-26. 62p. Dep. NTIS.

Borosilicate glass raschig rings have had limited use as a neutron absorber in solutions of fissile material for primary criticality control. The properties of raschig rings in physical, chemical, and radiation environments are presented along with specifications for individual rings and for packed beds of rings. Calculations and experiments which have resulted in the establishment of recommended limits on the concentration of solutions contained in large vessels packed with the rings are described. (auth)

9193 GEOTHERMAL ASPECTS OF RADIOACTIVE WASTE DISPOSAL INTO THE SUBSURFACE. Mufti, Irshad R. (Amoco Production Co. Research Center, Tulsa, Okla.). J. Geophys. Res.; 76: No. 35, 8568-85(10 Dec 1971).

A method is presented for calculating the temperature increase that results from heat generation by radioactive wastes placed in a subsurface cavity. Cavities of spherical, cylindrical, and other shapes are considered. The method takes into account the disintegration energy released by the various isotopes present in a waste and is applicable to wastes of all types, irrespective of their origin, age, or radioactive composition. This has been achieved by grouping the isotopes according to their decay characteristics. The procedure described is particularly useful when dealing with high-level wastes from power reactors. After a detailed examination of all the isotopes identified in significant proportions in a 90-day-old waste, it is demonstrated that when such a waste becomes 1 year old there are only 5 isotope groups that are mainly responsible for the heat generation. The number of groups reduces to 4 when the waste becomes 2 years old. In the theoretical treatment of the problem dimensionless parameters are used. These parameters make it possible to present the results in a few diagrams, which can be easily used for rapid determination of the temperature rise for a subsurface cavity containing radioactive waste. Since these diagrams do not depend on specific values of cavity dimensions, thermal constants of subsurface materials, or decay characteristics of the radioactive isotopes, they are applicable to a wide variety of situations that may be encountered in practice. By comparing the temperature rise from a subsurface heat source of constant strength with another that decays exponentially with time, the necessary conditions are determined for considering that the radioactive waste is a constant source of heat without introducing serious errors. As an application of the theory, the temperature field from a spherical cavity in rock salt containing a 2-year-old reactor waste has been investigated in detail. The space and time variation of the temperature, the maximum temperatures at various points, the rate of variation, the extent of penetration of the field, and the influence of this penetration on major geologic structures such as a salt dome are discussed. (auth)

9194 RADIOACTIVE SOURCE CONTAINER. Stein, Stephen (to National Research Development Corp.). British Patent 1,250,891. 20 Oct 1971. Filed 15 Jan 1968.

The object of the construction described is to provide a container that is capable of automatic operation, that has "fail safe" properties, and that provides a radioactive beam accurately to a given position. The container has a two-part radiation shield comprising a fixed part and a removable part, the latter butting against the former in the closed position. Continuously acting closure means are provided, together with suitable opening means and a latching mechanism for holding the movable part in the open position. The opening means can operate by springs or by electromagnetic or pneumatic action, and similarly for the closing means. In the event of failure the closure means operate immediately to close the shield and shut off the radiation. Timing mechanisms may be provided to determine the duration in the open position, and means may be provided for the radiation to be emitted in a radially extending sector only. (UK)

9195 IMPROVEMENTS IN AND RELATING TO RADIOACTIVE SOURCE CONTAINERS. Phillips, Robert John (to Graviner Manufacturing Co. Ltd.). British Patent 1,250,852. 20 Oct 1971. Filed 26 Jul 1969.

The construction described is such as to afford a high degree of protection against mechanical and thermal shock. It comprises a cup-shaped cork housing having a cup-shaped metal liner, and a radiation screen formed by casting molten lead into the space between the housing and its liner. A manufacturing method is described. A metal drum may be provided to form a shell around the housing; also a bolted-on lid. (UK)

9196 PACKAGING FOR TRANSPORTING AND STORING RADIOACTIVE MATERIALS. Blum, Paul (to Transnucleaire). French Patent 2,055,982. 19 Apr 1971. Filed 13 Aug 1969. (In French).

Packaging for storing and transporting radioactive materials is described. The composite wall consists of a core constructed of a dense material, providing protection against gamma radiation, and an outer wall provided with cooling elements, such as fins. A layer of a material with a hydraulic mortar or cement base separates the dense material from the outer wall. When the outer wall is provided with cooling elements, a layer of material of the same type is placed on the outer face of the outer wall, the cooling elements protruding from the surface; a neutron absorbing material can be incorporated in this layer if necessary. (France)

9197 PROCEEDINGS OF THE 19th CONFERENCE ON REMOTE SYSTEMS TECHNOLOGY, MIAMI BEACH, FLORIDA, OCTOBER 1971. Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Incorporated (1971). 224p. (CONF-711008).

Thirty-two papers on remote systems technology were presented at the conference. A separate abstract was prepared for each of 29 papers. Three papers appeared previously in NSA as 25: 51671, 25: 51672, and 25: 51933. (L.C.L.)

For abstracts of individual papers see: 9084, 9179, 9198–9220, and 9427–9430.

9198 HOT FUEL EXAMINATION FACILITY (HFEF). Swanson, N. J.; Mingesz, D. P.; White, J. R. (Argonne National Lab., Idaho Falls, Idaho). pp 3-13 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Construction of the nation's new hot cell complex has been completed. The Hot Fuel Examination Facility will serve the LMFBR Program for the interim and terminal examination of reactor fuel experiments. The location is the EBR-II site at the National Reactor Testing Station in Idaho. The equipment is currently being installed, and the plant will be operational in mid-1972. Two shielded cells are provided: one has an argon atmosphere and is for fuel examination; the other has an air atmosphere and is for decontamination, equipment maintenance, material transfer, and waste handling. The overall cost, including engineering and quality control, will be $10,200,000. The updated design and the construction experience are presented. (auth)

9199 TRANSFER PENETRATIONS AND EQUIPMENT FOR THE HFEF CELL COMPLEX. Kann, W. J. (Argonne National Lab., Ill.); Brak, S. B.; White, J. R. pp 14-19 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The cell transfer penetration system for the Hot Fuel Examination Facility (HFEF) is more complex than most other hot cell facilities. Provisions have been made to handle loops, tools, samples, and irradiated components of many different configurations through the various penetrations and transfer systems. Significant designs for cask cart, vacuum locks, and shield doors supported by air bearings are described. (auth)

9200 EQUIPMENT-DECONTAMINATION, MAINTENANCE, AND WASTE-TRANSFER PROVISIONS IN THE HFEF. White, J. R.; Taylor, D. S. (Argonne National Lab., Idaho Falls, Idaho). pp 20-7 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

As an integral part of the cell complex of the Hot Fuel Examination Facility, a shielded cell is provided for the wet decontamination of both irradiated material and in-cell equipment. The cell contains provisions for spray or immersion decontamination using steam, water, and mixtures of detergents. Waste, capsules, and experiments are transferred into offsite shipping containers using double-cover (alpha-contained) transfer mechanisms. A contact-maintenance area complete with a tunnel suit, glove panels, and personnel change rooms is attached to the Decontamination Cell for repair and rebuilding of in-cell equipment. (auth)

9201 GAS BOOSTER FOR USE WITH ARGON. Hirsch, P. R.; Marbach, R. A. (Argonne National Lab., Ill.). pp 28-31 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Several commercially available gas boosters were modified for operation with high-purity, potentially radioactive argon gas in the Hot Fuel Examination Facility. One of the boosters, as modified, was tested and found suitable for the intended application. Data comparing performance of the booster in air and argon were obtained from the test. (auth)

9202 INERT-ATMOSPHERE HOT CELLS FOR THE EXAMINATION OF IRRADIATED U–Pu FUEL ELEMENTS. Mason, P. A. Jr.; Frantz, C. E.; Montgomery, C. D. (Los Alamos Scientific Lab., N. Mex.). pp 32-7 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Seven alpha containment boxes capable of maintaining an inert atmosphere were operated in Wing 9 of the CMR Building during the past two years. Development and operation of these units has resulted in a capability of continuously maintaining an atmosphere of <10 ppM O_2 and <2 ppM H_2O through the use of recirculating purifier systems. Levels of <50 ppM O_2 and <10 ppM H_2O are achieved with argon once-through purge flow of 40 scfh. (auth)

9203 TREAT LOOP OPERATIONS WITH A NITROGEN GLOVE BOX FOR HANDLING PLUTONIUM-BEARING SPECIMENS. Willis, F. L.; Schmidt, K. J.; Dickerman, C. E.; August, C.; Dewey, G. G. (Argonne National Lab., Ill.). pp 38-43 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A nitrogen-atmosphere glove box was installed in an ANL hot laboratory for handling sodium loops and plutonium-bearing fuel specimens following TREAT irradiation. This glove box is equipped with a once-through nitrogen purging system which is exhausted through absolute filters. It is important that the outside surfaces of the loops do not become contaminated during handling and that contamination does not escape from the glove box into the room. These conditions are satisfied by the transfer port, which is a distinguishing feature of this glove box. By use of this device, the Mark-II loops are attached to a closed penetration in the glove-box wall and sealed with O rings. The loop body remains outside the box wihle the closure flange is opened, and the test section containing a failed fuel pin is transferred into the box. (auth)

9204 REMOTE HANDLING STUDIES AT ROCKY FLATS. Sheldon, O. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 64-8 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Remote handling was investigated for application to new plutonium-handling facilities at the AEC's Rocky Flats Plant as a method of operating with the minimum practical personnel radiation exposure. Currently the handling operations are done manually. Since the operations are repetitive, devices like the programmable industrial robot are being evaluated for use in the new facilities. The applicability of using the robot in a plutonium processing facility is discussed. Some of the other concepts that will be used in the new facilities are also discussed. (auth)

9205 MECHANICAL UPGRADING OF INDUSTRIAL ROBOTS. Aldred, J. K.; Latta, L. L.; Orr, J. A.; Ramer, P. C.; Zybura, J. G. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 69-74 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The hands normally supplied with Unimate robots have scissor-pivoted fingers and a clamping force which varies widely depending on the opening and the applied force. The need for a hand with parallel-closing fingers was filled by a specially designed hand. The activating linkage closes the fingers while keeping them parallel and maintains a nearly constant clamping force for the normally used input forces. The finger-changing mechanism found in some master-slave manipulators is incorporated into the robot's hand. Although reasonable success was attained in having the robot change its own fingers, there are problems that affect reliability. A hand-changing concept offers some advantages over the existing finger-changing methods. Different gripping techniques have been tested using some of the equipment and tooling that has been developed for a robot-served production facility. Ordinary gripping, pivot-swing handling, suction cup handling, inflatable rubber sections, and curling rubber fingers are being evaluated for use by the robot in a wide variety of applications. The wrist and hand motions of one robot are interactive in the standard machine. Since the controls of each motion are not suited for overcoming this problem, a gear train was designed to separate the motions and overcome certain programming limitations. Robots are normally fixed location items. A device has been built and tested which permits a robot to move any distance along a linear axis. (auth)

9206 ELECTRICAL UPGRADING OF INDUSTRIAL ROBOTS. Belcher, J. V.; Remley, L. A.; Ramer, P. C. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 75-80 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Reliable operation of the industrial robot requires communication between the robot and the equipment being serviced by it. Such communication is achieved through the use of programmed signals which are received from or sent to the equipment serviced. A lack of signal can inhibit the robot's motion until a contact closure is noted, or a signal can be sent from the robot to

actuate the equipment being served. In a remotely operated manufacturing process where the industrial robot replaces the operator, interlocks become of major importance in protecting the process and the robot. Any equipment misoperation must be detected. The industrial robots are usually a fixed-position device servicing only equipment at that position or handling parts delivered to it. One method for better utilization of the robot's capabilities is to move it from one preselected position to another, thus servicing several pieces of equipment. The major design criteria is to position the robot repeatedly within ±0.025 of an inch at each work station. (auth)

9207 FIXTURE DEVELOPMENT OF ROBOTIZED PRODUCTION OPERATIONS. Bert, J. D.; Ramer, P. C.; Zybura, J. G. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 81-7 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The first operations to be robotized are in a plutonium foundry. Some of the operations have already been accomplished by a robot in a nonplutonium environment. The dexterity of manual operators even in glove-box operations permits simple tooling to be used, but when the robot is used nearly every piece of equipment and tooling needs to include provisions for proper positioning. The robot does not correct for small errors in positioning tooling or parts. Therefore, each fixture must include guides to prevent cumulative errors from becoming excessive. (auth)

9208 MAINTENANCE AND CLEANUP CONSIDERATIONS IN A ROBOT-SERVED FACILITY. Belcher, J. V.; Bert, J. D.; Orr, J. A. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 88-94 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

In a facility that is remotely operated because it involves a hostile environment to man, maintenance considerations are of prime importance. For this reason the equipment used in this facility is designed or modified so it can be relocated within the contamination containment structure. Also, the maximum number of operating and control mechanisms that can be relocated are installed outside the hostile environment. If items cannot be removed, they are designed or modified so master-slave manipulators with special tools can be used to perform maintenance operations. (auth)

9209 DESIGN CRITERIA FOR IN-CELL INSTALLATION OF METALLOGRAPH STAGES. Cochran, F. L.; Hilbert, A. S.; Mattson, P. T. Jr. (Gulf General Atomic Co., San Diego, Calif.). pp 104-11 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The placement of metallographs and/or metallograph stages in-cell has always been avoided. The first metallograph installed where the stage is operative in (and retractable from) an in-cell position is described. The metallograph so installed was the Leitz MM-5 RT. The specific reason for breaking with design tradition (installation) was to avoid the troublesome mechanical transfer of specimens out-of-cell and to avoid the specimen size limitation associated with the transfer systems necessitated by out-of-cell units. (auth)

9210 ELECTRON MICROSCOPY SPECIMEN PREPARATION IN A HOT CELL. Chandler, T. L.; DuBose, C. K. H. (Oak Ridge National Lab., Tenn.). pp 128-31 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A need to examine highly radioactive material by transmission electron microscopy (TEM) led to the development of equipment to completely prepare TEM specimens in the hot cell. A commercial electroetcher forms the basis of the process. Basically, a specimen ($0.020 \times 1/8 \times 1/8$ in.) is held submerged in an electrolyte and a dc power source is applied between the specimen and the electrolyte. When a small hole is etched through the material, a photocell-light source system stops the action. The unit was extensively modified to upgrade the quality of specimens produced and to facilitate remote operation. The major modifications were the upgrading of the photocell detector system and the light source. Specimens reading 100 R/hr at 5 in. have been successfully processed by this method. (auth)

9211 ALPHA-GAMMA RADIOMETALLURGY LABORATORY AT CASACCIA NUCLEAR CENTER: DESIGN AND CONSTRUCTION. Cesarano, C.; Cudia, B.; Evangelisti, R.; Lauro, M.; Vescia, G. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 145-52 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The Casaccia Hot Laboratory has been in operation since 1962, and in the last five years it has been dealing with postirradiation analysis of ceramic fuel elements. The irradiation programs of CNEN, however, require a greater facility for postirradiation work on plutonium-bearing fuels. Design of the new facility was completed in 1970 and construction started in 1971. The facility and the general criteria that have been followed are described. (auth)

9212 CONCEPTUAL DESIGN OF FFTF INTERIM EXAMINATION/MAINTENANCE CELL. Harbison, S. G. (Aerojet-General Corp., Fullerton, Calif.); Graham, D. W.; Garrett, E. E. pp 153-9 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Expeditious examination of tests and selected driver fuel assemblies is being made possible at FFTF through provision of an interim examination cell in close proximity to the Fast Test Reactor. This cell, which will also be used for limited maintenance functions, will provide a controlled environment for receipt, cleaning, disassembly, nondestructive examination, and reassembly of FFTF core components with decay heats ranging up to 7 kW. (auth)

9213 REMOTE FACILITY FOR SPENT-FUEL SHIPPING CASK DECONTAMINATION. Albrecht, W. L.; Andrews, T. B. (Tennessee Valley Authority, Knoxville). pp 160-3 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The design of a facility in which a spent-fuel shipping cask containing highly irradiated (>30,000 MWd/MT) power reactor fuel is washed to remove transferrable radioactive contamination is described. Washing is accomplished remotely and automatically with moderately high-pressure hot water sprays. Areas not reached during remote cleaning are decontaminated by a hand method. A facility of this design is being installed in TVA's Browns Ferry Nuclear Plant to serve the three 1152-MW(e) boiling water reactor units. (auth)

9214 REQUALIFICATION EXAMINATION OF IRRADIATED FERMI SUBASSEMBLIES. Matte III, Joseph (Atomic Power Development Associates, Inc., Detroit). pp 164-71 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Fuel subassemblies which had comprised the core of the Enrico Fermi reactor at the time of the fuel melting incident of October 5, 1966 will be examined in a heated portable hot cell to determine their suitability for further use in the reactor. The hot cell facility, a gastight, shielded enclosure equipped with lights, viewing windows, and access ports for special tools, was originally constructed for nondestructive fuel examination to assist in determining the cause of the incident. A hoist mounted above the hot cell raises subassemblies out of storage in molten sodium into the hot cell. Newly designed inspection equipment installed in the cell performs straightness measurements, pin clad end-cap material sampling, testing of nozzle spring functioning, and visual examination. (auth)

9215 SUBASSEMBLY HEX-TUBE SLITTER. Hill, J. V.; Sales, W. L. (Argonne National Lab., Idaho Falls, Idaho). pp 189-90 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The design and operation of a subassembly hex-tube slitter to facilitate the disassembly of fuel subassemblies are described. The out-cell controlled slitter uses an existing vertical assembler-dismantler machine to support the subassembly and to provide the linear feed for the slitter, and a milling cutter with a depth-of-cut

adjustment of 0.001 in. Mechanisms are provided which compensate for the swelling, twisting, or bending in the subassembly, thereby preventing binding in the chuck and guide. (L.C.L.)

9216 APPLICATION OF THE SEALED-TUBE METHOD TO REMOTE DISSOLUTION OF IRRADIATED REFRACTORY MATERIALS. Dahlby, J. W.; Waterbury, G. R.; Montgomery, C. D.; Romanik, T. (Los Alamos Scientific Lab., N. Mex.). pp 191-3 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The use of the sealed-tube method for the remote dissolution of irradiated refractory materials is described. Samples containing up to 0.6 g of $(U,Pu)O_2$ fuel having 8% burnup were completely dissolved in less than 4 hr heating time using this method. The solutions prepared by this method were essentially "clean" and contained only the refractory material dissolved in hydrochloric acid. (L.C.L.)

9217 RADIOACTIVE SOLID WASTE COMPACTOR. Chandler, T. L. (Oak Ridge National Lab., Tenn.). pp 194-5 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The design and performance of a hydraulic press used at the Oak Ridge National Laboratory for compacting radioactive solid waste are described. (L.C.L.)

9218 EQUIPMENT FOR PREPARING SEALED METAL TUBES FOR LONG-TERM STORAGE OF IRRADIATED URANIUM–PLUTONIUM FUEL ELEMENT SECTIONS. Montgomery, C. D.; Romanik, T.; Trujillo, J. R. (Los Alamos Scientific Lab., N. Mex.). pp 200-2 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Equipment and methods are described for crimping and soldering metal tubes to provide an air-tight seal in tubes used for the long-term storage of irradiated plutonium–uranium fuel element sections. (L.C.L.)

9219 HEXAGONAL TUBING DIMENSIONAL MEASUREMENT DEVICE. Phipps, R. D.; Walker, K. L. (Argonne National Lab., Idaho Falls, Idaho). pp 203-4 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The design and performance of a device for remotely measuring the flat-to-opposite and corner-to-opposite dimensions of irradiated subassembly hexagonal tubing are described. (L.C.L.)

9220 DOUBLE-BOOT SYSTEM FOR MASTER-SLAVE MANIPULATORS. Eisert, G. A. (Central Research Labs., Inc., Red Wing, Minn.). pp 205-7 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The design and operation of a double-boot system for master-slave manipulators which operate in hot cells are described. The boot sleeve in the telescopic area of the manipulator is fabricated with urethane material in a convoluted shape. The boot sleeve in the non-telescopic area of the manipulator is of PVC film reinforced with nylon scrim. The equipment and method for installing and sealing the boot system in a 10-in.-ID wall tube are described. (L.C.L.)

9221 ELUTION AND HANDLING BOX FOR AN ISOTOPE GENERATOR. Delfosse, Jean; Douis, Michel (to Commissariat a l'Energie Atomique). French Patent 2,041,587. 18 Jan 1971. Filed 30 Apr 1969. (In French).

This elution and handling box for an isotope generator consists of a compartment, a reception chamber, and shielding. The generator consists of a thick-walled shielded container containing a radioactive substance in a column sealed by capsules. A trap for the first connecting tube is situated in the compartment above the shielded container. This tube is provided with a needle which admits the elution solution across the upper capsule of the column. A second connecting tube has a needle at each of its ends. (France)

9222 DEVELOPMENT AND PROOF TEST OF FUEL HANDLING GRIPPERS FOR JOYO, THE JAPAN EXPERIMENTAL FAST REACTOR. Abe, Shigeji (Fuji Electric Co. Ltd., Kawasaki, Japan). Fuji Jiho; 44: No. 2, 217-20(Feb 1971). (In Japanese).

Results from the development and performance testing of fuel handling grippers for use in JOYO, the Japanese Experimental Fast Reactor, are reported. The fuel handling grippers include two types: one is a fuel gripper for a fuel changing machine and is used for in-core fuel changing; and the other is a pot gripper for a fuel transfer machine and is used for fuel pot transfer from the core to outside of the core. In order to prove reliability of function of the fuel and pot grippers, they were individually tested both in atmosphere and in sodium. Repeated-operation tests were carried out in sodium, taking working frequency into consideration. Both grippers were successful in the tests. For the atmospheric conditions, performance of the grippers was ascertained together with gripping under eccentric condition of 10 mm. Under sodium conditions with 10 ppM O_2 at 250°C and under the cover gas the performance tests were repeated continuously 1200 times and the grippers proved to be satisfactory. No change was observed in the gripping mechanism. The structure, material, and surface treatment were adequate. (Japan)

9223 DEVICE FOR SHUTTING OFF AN ORIFICE. Chevalier, Georges; Jacquinet, Louis; Martin, Jean-Paul; Nicol, Christian; Valluy, Robert. (to Commissariat a l'Energie Atomique). French Patent 2,063,945. 16 Jul 1971. Filed 8 Oct 1969. (In French).

A shut-off device is described which is used to gain access through the walls of the orifice of a sealed enclosure such as a chamber affording protection against radioactive radiations. It is designed to facilitate the servicing or repairing of the sheathed tubes of the channels containing nuclear reactor fuel elements. This device involves: a tubular shut-off part, supported by a prop, which presses against a fixed part; a device which slides up and down inside the extending part of the shut-off part during its expansion; an expansion spring for the prop and shut-off part. (France)

9224 FLUID BYPASS SYSTEM. Conrad, Hubert (to Commissariat a l'Energie Atomique). French Patent 2,057,244. 26 Apr 1971. Filed 7 Aug 1969. (In French).

The problem of temporarily bypassing the entire flow of gases is frequently encountered in installations in which gases from the vessels of reactors are released to the atmosphere. A bypass system is described, in which the entire quantity of fluid normally flowing in the first branch of a tube is directed into a second branch provided with the appropriate means of treating the fluid. A portion of the main branch is isolated by shutting off the fluid at two points and injecting into this isolated portion another fluid, which is compatible with the first, but at a greater pressure. In this way, should a leak arise, it will take place in the direction away from the isolated branch towards the second branch. (France)

9225 FORCED AIR COOLED RADIOACTIVE MATERIALS CONTAINER. Smith, Carrel W. (to General Electric Co.). U. S. Patent 3,619,616. 9 Nov 1971. Filed 24 Jan 1969.

An improved radioactive materials container system having a system of ducts and nozzles for efficient forced air cooling of a finned radioactive materials container is described. (Official Gazette)

9226 DRY ENCLOSURE. Pottier, Raymond (to Commissariat a l'Energie Atomique). French Patent 2,055,985. 14 May 1971. Filed 14 Aug 1969. (In French).

A dry enclosure was developed, which is intended for manipulating dangerous substances, in particular radioactive substances. The apparatus consists of an inner box and an outer box. Dry gas flows through both boxes, the inner box is maintained at a greater pressure than the outer box, which is itself at a pressure in excess of the atmosphere outside. (France)

9227 PM-3A-M SHIELDED CASK (Jun 1971) (Engineering Materials). (Savannah River Operations Office (AEC). Aiken, S. C.). (CAPE-2144).

16 drawings.

The cask, essentially an upright circular cylinder, is a Pb-filled stainless steel weldment with a top closure. The cask is mounted on a 10-in. high Al pallet for shipment and is equipped with a steel fire shield (shroud) with louvers at the top and bottom openings. The shroud is affixed to the cask frame which consists of four vertical H beams with 6-in. wide flanges. Additional framing members are placed over the cask cover and joined to the four vertical H beams. The outer cask wall has fins welded to it. Two trunnions are welded to the outside of the cask. A drain valve, pressure relief valve, and a pressure gage are provided. The cask is used to ship spent dry PM-3A reactor cores, Type II or IV from the power plant at McMurdo Sound, Antarctica, to pro-

cessing sites in the U. S. Nuclear criticality safety of the core is dependent upon all control rods being fully inserted and the K_{eff} of the core (moderated by water) being no greater than 0.95 under these conditions. (For details see TID-4100, Suppl. 67) (see also 25: 44565) (F.S.)

9228 FISSILE MATERIAL SYMBOL. ANSI N12.1 1971. New York; American National Standards Institute (1971). 4p.

A standard is presented which specifies the symbol to be used to signify the presence of fissile material. Since fissile material is radioactive, the symbol inherently signifies the presence of radioactive material. This symbol also signifies the presence of any associated radioactive material. It does not specify the quantity of fissile or associated radioactive material which require use of this symbol. (auth)

9229 MODELS FOR THE SAFE STORAGE OF FISSILE METAL. Altschuler, S. J.; Schuske, C. L. (Dow Chemical Co., Golden, Colo.). Nucl. Technol.; 13: No. 2, 131-47(Feb 1972).

Two models are described for calculating critically safe storage configurations for uranium (93.4 percent uranium-235) and plutonium (96 percent plutonium-239, 4 percent plutonium-240) metal. The first model deals with conventional arrays in air of fissile units surrounded by concrete walls. The model uses the concepts of surface density and unit surface-to-volume ratio to define safe-array parameters. The second model makes use of thick internal moderators (i.e., water) enclosing each storage unit in an array. These arrays are also surrounded by concrete walls. The internal moderators partially isolate adjacent storage units from one another and thus, in some cases, permit extremely high surface densities and vault loading. Several factors that influence the storage model are shape and density of the individual storage units and the degree of reflection of arrays of units. (auth)

9230 TRANSFER DEVICE. Godart, Michel (to Commissariat a l'Energie Atomique). French Patent 2,059,937. 11 Jun 1971. Filed 10 Mar 1969. (In French).

A sealed device for transferring contaminating objects (principally radioactive) to a vessel on the other side of an enclosure wall, is described. This device consists, essentially, of a tube, which crosses the wall by means of a gas-tight fitting; the tube has an internal diameter corresponding to the vessel aperture. A sealed band provided with holes corresponding to the internal diameter of the tube crossing the wall is driven from the outside towards the interior of the enclosure in such a way that the holes pass alternatively between the tube and the vessel. The communication between the tube and the vessel can thus be either, free or obstructed. The transfer of fuel pellets containing Pu from a contaminated cell into a fuel can be effected. (France)

9231 IMPROVEMENTS TO CONTAINERS FOR RADIOACTIVE SUBSTANCES. (to Robatel-SLPI). French Patent 2,062,013. 1 Jun 1971. Filed 7 Oct 1969. (In French).

The outside wall of this container, used for transporting and/or storing radioactive materials, possesses cooling fins. A demountable envelope encloses the fins, the space between the fins and the envelope being simultaneously connected to a blower and the atmosphere outside. The envelope consists of a series of panels attached to the outside wall of the container in such a way as to detach themselves automatically in the case of a temperature rise due to the malfunctioning of the blower. (France)

9232 IMPROVEMENTS FOR PACKAGING INTENDED FOR STORING OR TRANSPORTING RADIOACTIVE OR SIMILAR MATERIALS. (to Robatel SLPI). French Patent 2,055,761. 30 Apr 1971. Filed 12 Aug 1969. (In French).

A procedure for insulating packaging intended for transporting radioactive and similar materials is described. The packaging is provided with lead shielding and an external metallic envelope, which is to be packed with the insulating material; this insulating material consists of a mixture formed by Al_2O_3, $3H_2O$, and iron or soft steel powder; it is poured into the free space provided. (France)

ENVIRONMENT AND EARTH SCIENCE

Geology and Hydrology

Refer also to abstracts 8786, 9006, 9010, 9091, 9164, 9289, 9405, 9407, 9409, and 9412.

9233 (CONF-711113-4) PRINCIPLES AND PRACTICES IN THE DISPOSAL OF RADIOACTIVE WASTE TO FRESH WATERS. Slansky, Cyril M. (Allied Chemical Corp., Idaho Falls, Idaho). 1 Oct 1971. 14p. Dep. NTIS.

From Regional training course in radioactive waste management conference; Tokyo, Japan (4 Nov 1971).

The features of fresh surface water, the assessment of the risk to man, and discharge practices which are important in a satisfactory radioactive waste management program are described. Included is a discussion of the hydrological cycle, ecology and water, transport of radionuclides in the aquatic system, the critical pathway concept, dose limits, safe release limits, assessing discharges, and waste management policy. (auth)

9234 (CONF-711113-5) ULTIMATE STORAGE OF RADIOACTIVE WASTE. Slansky, Cyril M. (Allied Chemical Corp., Idaho Falls, Idaho). 14 Sep 1971. 12p. Dep. NTIS.

From Regional training course in radioactive waste management conference; Tokyo, Japan (4 Nov 1971).

The ultimate storage of high-level radioactive wastes is defined as storage on earth with the following conditions: storage periods of the order of a million years, inaccessibility of the waste to man or his food chain, no surveillance or maintenance, and costs that would be commensurate with the benefits. Availability of the method to all nuclear nations would be a desirable characteristic. Methods for ultimate storage in ocean trenches and depths and for underground storage in salt deposits, crystalline bedrock cavities, and hydrofractured shale formations are discussed. Finally, methods for ultimate disposal, i.e., eliminating the waste from the earth environment by transmutation of the radioisotopes to stable isotopes or by waste shipment to other planets or the sun, are described. It is concluded that, at present, the most favorable ultimate storage conditions are in deep underground cavities in geologic formations and that further experimental research must be done to evaluate deep ocean regions and nuclear cavities as ultimate storage sites. (L.C.L.)

9235 (INP-760) DIFFERENTIAL INTERPRETATION OF GAMMA-RAY LOGS. I. CASE OF THE STATIC GAMMA-RAY CURVE. Czubek, Jan Andrzej (Institute of Nuclear Physics, Krakow (Poland)). May 1971. 55p. Dep. NTIS (U. S. Sales Only).

The problem of digital interpretation of natural gamma logs is presented. The solution of the Fredholm integral equation of the type $I(z) = \int_{-\infty}^{\infty} q(x) \cdot \phi(z - x) \cdot dx$ is given to obtain the radioactive ore grade distribution q(z) along the borehole axis when the deflections I(z) in gamma logs of the static type are available. This solution was found in the form of rapidly convergent series $q(z_0) = \Sigma_{j=-p}^{+p} I(z_j) \cdot b_j$; p = 1,2,3,... where the coefficients b_j are given by the analytical formulas, taking into account the borehole radius R, the length of detector L, the thickness Δh of a hypothetical layer, and the effective gamma absorption coefficient μ of the rock. All the numerical data needed for the calculations are included. Examples of gamma log interpretation using this method are given and results are compared with those reported by others. (auth)

9236 (NVO-1229-141) HYDROLOGIC CONTAMINATION PREDICTION METHODOLOGY. Nork, W. E. (Teledyne Isotopes, Palo Alto, Calif.). May 1970. Contract AT(29-2)-1229. 10p. Dep. NTIS.

Prior to an underground nuclear event, a careful prediction of groundwater contamination is made. This prediction is developed by calculation, using conservative values for the following factors: anticipated radionuclide production; probable physical effects of the explosion; and hydrologic characteristics of the site. The site hydraulic system is initially modified by the explosion-produced rubble chimney, which acts as a sink toward which groundwater flows. Time of chimney infill is calculated from the predicted chimney configuration and the hydrologic characteristics of the surrounding rocks. After this period of time, usually a few years, radioisotopes are free to migrate down the hydraulic gradient. Direction and rate of movement are calculated from basic formulas governing groundwater movement and chemical exchange retardation. Laboratory measurements on sample rocks provide necessary data on the rocks' sorptive capacity for specific isotopes. Computer programs are written to provide a capability to predict the precise location of explosion-produced radionuclides in water at any concentration and at any time. The final prediction report, in addition to defining the expected groundwater contamination, relates such contamination to known water-use points, notes pre-explosion background radioactivity levels, and recommends post-event monitoring programs. (auth)

9237 (RT/GEO-(70)15) SOME SIGNIFICANT RESULTS OF MEASUREMENT OF DENSITY AND NATURAL WATER CONTENT OF SOILS WITH GAMMA-RAY AND NEUTRON PROBES IN GEOTECHNOLOGY. Orsini, A.; Pirastru, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [1970]. 23p. (In Italian). (CONF-701061-2). Dep. NTIS (U. S. Sales Only).

From tenth conference on geological techniques; Bari, Italy (26 Oct 1970).

In recent years the CNEN Laboratory for the Application of Radioisotopes to Hydrogeology, and Bari University Institute of Engineering Geology have been engaged in the practical application of the results of earlier theoretical research concerning the use of nuclear probes for determining the density and natural water content of soils. Though the basic method has been known for some time and the relevant apparatus has been widely available, until fairly recently cases in which the mere application of basic concepts gave only very broad approximate results were all too common. The results of practical on-site application of this technique in a wide variety of geological environments are discussed. Particular reference is made to measurements performed in soils high in organic matter (alternations of peat and lake silts at Massaciuccoli–Pisa), in alternations of debris from landslides in flysch zones of the Apennines (Val di Sangro–Abruzzi), in pyroclastic soils (tuffs and pozzolane Napoli), and in glacial till (Pisayambo–Ecuador). The results obtained confirm the usefulness of these methods, especially where subsoil conditions are such that it is difficult to take undisturbed samples. (auth)

9238 (UCRL-51099) HIGH-PRESSURE MECHANICAL PROPERTIES OF TUFF FROM THE DIAMOND MINE SITE. Heard, H. C.; Schock, R. N.; Stephens, D. R. (California Univ., Livermore. Lawrence Livermore Lab.). 19 Jul 1971. Contract W-7405-eng-48. 21p. Dep. NTIS.

Pressure-volume, acoustic velocity, plane stress, plane strain, and failure envelope measurements have been made on four representative samples of tuff from the Diamond Mine site. The results were consistent with those determined for Diamond Dust tuffs and were typical of weak, partially saturated tuffs in general. The compressibilities were large at low pressures because of pore collapse; at pressures greater than about 5 kb the tuff became much less compressible. Shear strengths were uniformly low: 150 to 300 bars at pressures ranging up to 4 kb; at higher mean pressures, strengths rose markedly. The elastic constants derived from acoustic velocity, plane stress, and plane strain measurements were observed to be extremely dependent upon the relative levels of shear stress and mean pressure: the initial bulk modulus and Poisson's ratio of 32 kb and 0.17 rose to about 100 kb and 0.3 to 0.4, respectively, with the addition of only a few hundred bars of mean pressure or shear stress. (auth)

9239 (USGS-474-74) MARINE GEOPHYSICAL STUDY AROUND AMCHITKA ISLAND, WESTERN ALEUTIAN ISLANDS, ALASKA. Amchitka-22. von Huene, Roland; Carr, W. J.; McManus, Dean; Holmes, Mark (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 35p. Dep. NTIS.

Marine geophysical surveys made around Amchitka in 1969 included fathometer, seismic reflections, and magnetic recording along ship's tracks totaling more than 1,200 km. Stratigraphy and structure of the Amchitka Island area can be extrapolated in a general way to help explain and interpret the marine seismic and magnetic records and submarine topography. Differences in submarine geomorphology around Amchitka reflect basic structural elements related to development of the island arc. The seismic records around Amchitka indicate a general scarcity of highly reflective layers in the bedrock. In a few areas on the insular shelf and upper slopes very thin sediments are present, commonly adjacent to fault scarps; in a few such areas these relatively young sediments appear to have been slightly displaced or tilted by faulting. Thicker sediments are present, however, in the deep valleys and basins north and east of Amchitka. These, too, have apparently been disturbed locally by minor faulting. The largest fault known on Amchitka does not appear to extend very far seaward, and the major faults on the island

cannot confidently be connected directly with prominent submarine fault scarps south of Amchitka, although the island and submarine faults appear to belong to the same structural pattern. The marine geophysical work, together with other evidence, suggests general stability for the area around Amchitka during at least the last ten thousand years, but relatively recent minor local warping, faulting, and probably slumping have occurred along the Rat Islands Escarpment and at a few other locations adjacent to Amchitka. (auth)

9240 (USGS-474-130) PETROLOGY AND MINERALOGY OF TATUM DOME, LAMAR COUNTY, MISSISSIPPI. Schlocker, Julius (Geological Survey, Denver, Colo.). 1963. Contract AT(29-2)-474. 103p. Dep. NTIS.

This study of the petrology and mineralogy of Tatum dome, Lamar County, Miss., is based mostly on drill cores from holes WP-1 and WP-4, 1,600 ft apart in the central part of the dome. The top of the salt stock is nearly flat, about 1,231 ft below sea level, and about a mile in diameter. The dome has a caprock of anhydrite, 403 to 468 ft thick, which is overlain by cavernous limestone caprock, 86 to 152 ft thick. A zone of no core recovery, 2 to 4 ft thick, that lies between the limestone and anhydrite caprock, may represent a gypsum caprock zone. The dome is overlain with slightly arched beds of clay and sand of Miocene to Holocene age about 930 ft thick. Data are presented on the composition, layer thickness, and crystallization characteristics of the geologic layers. (L.C.L.)

9241 DETECTION OF ^{244}Pu IN NATURE. Hoffman, D. C. (Los Alamos Scientific Lab., N. Mex.); Lawrence, F. O.; Mewherter, J. L.; Rourke, F. M. Nature (London); 234: No. 5325, 132-4(19 Nov 1971).

Mass spectrometric measurements of plutonium isolated from Precambrian bastnaesite confirmed the presence of ^{244}Pu in nature. Although the existence of ^{244}Pu as an extinct radioactivity has been postulated to explain the xenon isotope ratios observed in meteorites, this is the first indication of its present existence in nature. (auth)

9242 INVESTIGATION OF GROUND WATER BY MEASUREMENT OF NATURAL RADIOACTIVITY. Ochiai, Toshiro (Agricultural Engineering Research Station, Hiratsuka, Japan). Radioisotopes (Tokyo); 20: No. 5, 245-51(May 1971). (In Japanese).

Two methods of prospecting for ground water by natural radioactivity (direct detection with GM or scintillation counter and radon method) are explained with some reviews on their development and references to some problems in their application. A number of examples of investigation and prospecting by the two methods are cited, including those concerning radon content in gneiss fields, natural radioactive intensity of soil samples, and ground water prospecting using gamma spectrography. The radon method, however, is now losing its popularity, and the direct method is more frequently used. (Japan)

9243 U-Th-Pb LEAD ISOTOPE STUDY OF ROCKS AND ORES FROM BROKEN HILL, AUSTRALIA. Reynolds, P. H. (Australian National Univ., Canberra). Earth Planet. Sci. Lett.; 12: No. 2, 215-23(Oct 1971).

A lead "double-spike" calibrated against an NBS Standard was used to obtain the isotopic abundances of total-rock samples of high-grade gneiss from the Mine Sequence, Broken Hill. New lead isotope data for a number of Thackaringa Type ore leads are also reported as are the lead, uranium, and thorium concentrations of the rock samples. An age of 1690 ± 35 Myr was calculated from the apparent linear relationship of the rock leads on a $^{207}Pb/^{204}Pb-^{206}Pb/^{204}Pb$ diagram. This agreed with previously reported Rb-Sr results and was similarly interpreted as the time of the regional high-grade metamorphism. Recent mobility of uranium and thorium may account for the considerable scatter of the rock data when plotted on conventional U-Th-Pb isochron diagrams. The slope of the least squares line through the galena data on a $^{207}Pb/^{204}Pb-^{206}Pb/^{204}Pb$ plot was substantially higher than values previously reported. It is therefore suggested that Thackaringa mineralization occurred approximately 800 Myr ago, prior to the retrograde metamorphism dated at 500 Myr. The common lead component in both Thackaringa ores and high-grade gneisses may be isotopically identical to lead from the main lode orebody (that is, Broken Hill Type lead). Hence, formation of this orebody with lead derived from local source rocks at the time of the high-grade metamorphism may be indicated. Alternatively, as suggested by Stanton, metamorphism of ore and host rocks soon after syngenetic deposition would be likely to give the observed isotopic results. (auth)

9244 CHARGED-PARTICLE TRACK REGISTRATION IN AMBER. Uzgiris, E. E.; Fleischer, R. L. (General Electric Co., Schenectady, N. Y.). Nature (London); 234: No. 5323, 28-30(5 Nov 1971).

Amber samples may have recorded rare cosmic-ray events, such as the passage of magnetic monopoles; also, if ^{238}U spontaneous-fission-fragment trails are preserved in the amber for a sufficiently long time, then the track-dating technique should be applicable to the dating of amber deposits. The technique of etching fission-fragment tracks in this material is described, and data are given on the ionization damage threshold for track registration, on the annealing of formed tracks, and on the abundance of ^{238}U. $K_2Cr_2O_7$ in H_2SO_4 was found to be a satisfactory etching solution for amber at 40°C. Amber, being a resinous material, could be expected to have a lower threshold than minerals or glasses, but it was found to have a very high threshold. The track-formation properties of amber relative to mica as studied, using slowed ^{252}Cf fission fragments, are indicated. No tracks were formed by ion beams of ^{20}Ne at 10 MeV/amu or ^{37}Cl at 2 MeV/amu at normal incidence. Track fading is discussed, and data are given on annealing effects, from which it is concluded that tracks from ^{238}U fission would remain from the fossilisation period to the present time. The use of amber for registering monopoles is discussed. The ^{238}U content in amber samples was determined and found to be very variable. The oldest track storage age consistent with both the annealing curve and the measured ^{238}U abundance is about 350,000 yr, but they may be older. (UK)

9245 AGE AND ORIGIN OF KOEFELS STRUCTURE, AUSTRIA. Storzer, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Horn, P.; Kleinmann, B. Earth Planet. Sci. Lett.; 12: No. 2, 238-44(Oct 1971).

The fused rock from Koefels yields a fission track age of $0.8 \pm 6.0 \times 10^3$ yr. Because of the low age of the "Koefelsite" and the extremely small density of fossil fission tracks the fission track method is operating at its methodical limits. Nevertheless, it is remarkable that even in this extreme case an age can be estimated which is in plausible agreement with geological and ^{14}C results. Lechatelierite, feldspar glasses, and probable chaoite in "Koefelsite" prove that temperatures far above those common for igneous processes existed at the time of formation. The presence of the tomorphic quartz, maskelynite, and multiple sets of planar features in quartz and feldspars strongly indicates shock metamorphism. At present these features can only be explained by a meteoritic impact origin of the "Koefelsite" and the Koefels structure. (auth)

9246 U-Pb AGES FOR SPHENE IN A CONTACT METAMORPHIC ZONE. Hanson, G. N. (State Univ. of New York, Stony Brook); Catanzaro, E. J.; Anderson, D. H. Earth Planet. Sci. Lett.; 12: No. 2, 231-7(Oct 1971).

U-Pb ages have been determined on sphene concentrates from the 2700 Myr old Giants Range Granite at varying distances from the contact with the 1100 Myr old Duluth gabbro. As the contact is approached the sphene ages become more discordant and plot along a chord between 1100 and 2700 Myr on a concordia diagram. The U-Pb ages for sphene in the contact aureole are more resistant to thermal metamorphism than are K-Ar ages for hornblende and biotite. The resistance relative to U-Pb ages for zircon is more difficult to interpret because the zircon U-Pb ages may have become discordant prior to or after 1100 Myr ago, whereas the U-Pb ages for sphene appear to have had episodic discordance only at 1100 Myr ago. (auth)

9247 AGE DETERMINATION OF THE GLASS PORTION OF EFFUSIVE ROCKS USING SPONTANEOUS NUCLEAR FISSION TRACKS OR ^{238}U. Kraushaar, Juergen; Ackermann, Wilhelm. Aufschluss; 21: No. 9, 284-93(1970). (In German).

Increasing interest in the fission-track method of dating prompts this report on the present state of the method. The theory and its application to geologic materials, the technology, sources of error, and some results obtained on volcanic glasses are discussed. Although the errors are still very high, here and there quite good agreement was found with the results of other dating methods. The present investigations appear to justify the hope that in the future, with consideration of the requirements for choosing the samples to be measured, this dating method will provide trustworthy results, and conversely, that reliable corrections may be established empirically for some still uncontrollable sources of error. (Geophys. Abstr.)

9248 URANIUM DISTRIBUTIONS IN ARCHEOLOGIC CERAMICS: DATING OF RADIOACTIVE INCLUSIONS. Zimmerman, D. W. (Washington Univ., St. Louis). Science; 174: No. 4011, 818-19(19 Nov 1971).

Small mineral grains (10 to 50 micrometers) of high uranium

concentration (100 to 3000 ppM) were located in polished sections of eight potsherds from Cyprus, England, Greece, and Mexico by induced fission-track mapping. Most of the grains were identified as zircons or apatites by a microprobe attachment to a scanning electron microscope. The advantages in using such radioactive grains for thermoluminescence dating and alpha-recoil track dating are discussed. (auth)

9249 ^{14}C AGE AND TRITIUM CONTENT OF LAKE VANDA, WRIGHT VALLEY. Jones, Lois M. (Univ. of Georgia, Athens); Oestlund, H. Goete. Antarctic J. U. S.; 6: No. 5, 200-1(Sep-Oct 1971).

During the 1969 to 1970 austral summer, samples of water from Lake Vanda were collected for ^{14}C analyses. At least two levels of water in Lake Vanda were abnormally high to ^{14}C content. The only potentially reliable values are the dates for water at 25 m and 60 m. Tritium analyses (reported as tritium units (TU), $10^{18} \times$ molar fraction T/H) are given. The results for the deepest layer are uncertain, and they are not reported. Factors affecting the data are discussed. (P.C.H.)

9250 RADIOACTIVE ANOMALIES OF CRUST-PROPER TYPE. Vasil'eva, V. I. Izv. Akad. Nauk SSSR, Ser. Geol.; No. 9, 126-8(1970). (In Russian).

Data are presented on a new type of radioactive anomalies, detected in the weathered crust of an arid climate region. They are called "radioactive anomalies of crust-proper type." Their origin is related to the formation of ancient weathered crust, by precipitation of uranium on a sorption barrier in the middle horizon of the weathered crust of Proterozoic-Paleozoic granitoids and schists. The geochemical characteristics of such anomalies were examined. It was concluded that these anomalies must be distinguished from primary aureoles of uranium dissemination. (Geophys. Abstr.)

9251 RADIOACTIVE ELEMENTS IN ROCKS AND MINERALS OF THE TOKOV GRANITE MASSIF. Zhukova, A. M. Geofiz. Sb., Akad. Nauk Ukr. SSR, Inst. Geofiz.; No. 37, 56-64 (1970). (In Russian).

The radioactive element content of the Tokov granite massif was determined on the basis of measurements of α, β, and γ activities. The Tokov granite had the highest uranium and thorium content of the granites of the Middle Dnieper area. Thorium was generally prevalent (Th/U about 10); some rocks were relatively enriched in uranium (Th/U = 0.8 – 3.0), in zones of sulfide mineralization or metasomatism. The radioactive elements were present in mineral form and in dispersed form. Two types of orthite were present, containing 0.12 and 0.41 percent uranium equivalent, respectively; the former was present in all the rocks, the latter mainly in metasomatically altered rock. (Geophys. Abstr.)

9252 RADIOACTIVITY OF GROUND WATERS FROM LANDSLIDE AREAS AND VICINITY. Hirayama, Mitsuei (Utsunomiya Univ., Japan). Utsunomiya Daigaku Kyoikugakubu Kiyo; No. 19, 39-43(Dec 1969). (In Japanese).

Radioactivity measured by using an I. M. fantastoscope to determine the radon content in ground waters collected from four landslide areas in Tertiary strata showed the following results: the radon content of the waters investigated ranges from ≈0.02 to 0.06 mCi/l; in all cases the radioactivity of ground waters from a landslide area is lower than that from the surrounding vicinity; and the radioactivity is higher in ground waters at lower temperature. (auth) (Japan)

9253 EFFECT OF THE DIAMETER OF DRY WELLS ON GAMMA–GAMMA DENSITY LOGGING. Popov, E. P. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 141-3(1969). (In Russian).

A method of taking account of variations in well diameter in $\gamma-\gamma$ logging with symmetrical 4π sondes is proposed which makes it possible to determine the true density value in wells of variable diameter, on the basis of a formula relating the true and measured density values as a function of well diameter and sonde construction. The parameters entering into the formula are determined for each specific measuring set-up by means of measurements in the well on two marker layers. (Geophys. Abstr.)

9254 RADIOACTIVE TRACER WELL LOGGING. Davis, Mike; Youmans, Arthur H. (to Dresser Industries, Inc.). U. S. Patent 3,600,582. 17 Aug 1971. Filed 3 Jun 1968.

The thermal neutron capture cross section of the fluid in an earth borehole is altered by the addition of a soluble neutron absorber and a radioactive tracer material, the tracer material serving to facilitate location of the injected fluid by means of a radiation detector and the neutron absorber serving to facilitate measurement of the pore volume occupied by the injected fluid in the formations surrounding the borehole by measurement of the thermal neutron capture cross section of the formation. (Official Gazette)

9255 NUCLEAR SITES AND RADIOLOGICAL SAFETY STUDIES. Barbreau, A.; Escalier Des Orres, P.; Le Quinio, R. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 7-13(Apr 1971). (In French).

The radiological safety studies carried out in connection with nuclear sites involve the evaluation and the subsequent minimization of the risks associated with the release of radioactivity into the environment. Radioactivity may be transferred in the environment by the atmosphere, surface water, or underground water. Site studies necessitate a knowledge of transport, diffusion, and concentration mechanisms in these different media. Geological, seismological (where relevant), meteorological, hydrology, and oceanographic (for sites situated near the sea) studies must be made. (France)

9256 SURFACE GAMMA SPECTROMETRY OF RADIOACTIVE CONTAMINATION OF A LOCALITY. Artemov, E. M.; Balyasnyi, N. D.; Kogan, R. M.; (and others). At. Energ. (USSR); 31: No. 1, 35-40(Jul 1971). (In Russian).

Near the terrestial surface the gamma spectrum of regional contamination depends on the distribution of γ-emitters in the soils and the microtopography. A mathematical treatment of this idea (assuming smooth, level terrain) led to the conclusion that directional detectors decrease the error in ^{137}Cs determinations in the ground, for example, by 2 to 7 times in comparison with measurements using isotropic detectors. A treatment of the influence of the microtopography revealed a dependency of the optimum angle on the level of existing contamination, the angle being within the limits 50 to 70° for local ^{137}Cs contamination. Experiments have shown that it is possible to neglect the microtopography in the case of old fallout. (K.S.W.)

9257 DISTRIBUTION OF URANIUM BETWEEN PRECIPITATES AND BRINES IN THE SOLAR SALT PLANT OF MARGHERITA DI SAVOIA. GEOCHEMICAL AND GEOLOGICAL CONSIDERATIONS. Dall'Aglio, Mario; Casentini, Enrico (CNEN, Rome). Boll. Soc. Geol. Ital.; 89: 475-84(1970). (RT/GEO(71)2).

The behavior of uranium during the solar salt production process was studied. The research was conducted at one of the world's largest solar salt plants—located at Margherita di Savoia, Foggia—producing 600,000 tons of sodium chloride per year. The uranium content was determined in the brines, in the gypsum, and the sodium chloride precipitates. The results obtained show that uranium is concentrated in the final bitterns, the contents of which exceeds 30 micrograms per liter. The contents of uranium in the gypsum and sodium chloride are very low, i.e., from 0.1 to 0.001 ppM. The acid insoluble residues of salts show a higher uranium content, that is in the order of ppM. The geochemical and geologic significance of the results obtained is also discussed. (auth)

9258 QUANTITATIVE INTERPRETATION OF THERMAL NEUTRON DECAY TIME LOGS. PART II. INTERPRETATION EXAMPLE, INTERPRETATION ACCURACY, AND TIME-LAPSE TECHNIQUE. Clavier, C.; Hoyle, W.; Meunier, D. J. Petrol. Technol.; 23: 756-63(Jun 1971).

An example of quantitative interpretation of thermal decay time (TDT) logs is presented, along with a discussion of the errors that can be tolerated on each parameter involved. Also discussed is the time-lapse technique, which evaluates saturation changes by comparing logs run at different times in a well's production history. (auth)

Meteorology

Refer also to abstracts 9010, 9255, 9328, 9486, 9521, and 9539.

9259 (BARC–549) FALLOUT STUDIES ON THE CHINESE AND FRENCH NUCLEAR TESTS DURING 1964–69. Vohra, K. G.; Mishra, U. C.; Sadasivan, S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 43p. Dep. NTIS (U. S. Sales Only).

The studies made on fresh fallout radioactivity from the Chinese and French tests during 1964 to 69 are reported. The method of collection of samples and the procedures for their analysis are briefly described. Detailed discussions on the results for all the tests studied are given. The study has provided valuable information about the weapons tested e.g., the type of weapon, fissile material, tamper, etc. The usefulness of such a study and the scope for further work have also been discussed. (auth)

9260 (COO–2053–6) WIND-TUNNEL STUDY ON GASEOUS MIXING DUE TO VARIOUS STACK HEIGHTS AND INJECTION RATES ABOVE AN ISOLATED STRUCTURE. Meroney, R. N.; Yang, B. T. (Colorado State Univ., Fort Collins. Fluid Dynamics and Diffusion Lab.). Nov 1971. Contract AT(11-1)-2053. 47p. Dep. NTIS.

A systematic study of gaseous dispersion about an isolated building structure was conducted. In order to estimate the maximum ground concentration distribution, the conventional formulas were compared with the wind tunnel results. Different stack heights were monitored both by smoke visualization and quantitative concentration measurements. The related parameters such as building orientation, stack height, and exit momentum are discussed. The experiment was conducted in a thick, neutral boundary layer, and ^{85}Kr, was used as a tracer for concentration measurements. (auth)

9261 (LA–4790) COMPILATION AND STUDY OF METEOROLOGICAL DATA FOR LOS ALAMOS, NEW MEXICO, 1956 THROUGH 1970. Arntzen, E. G.; Foley, W. R. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 118p. Dep. NTIS.

Meteorological data for Los Alamos, New Mexico, for 1956 through 1970 are available on magnetic tape in the Mechanical Design Section of LASL Group ENG-2. These data include the hourly dry-bulb temperatures; relative humidity; wet-bulb temperatures for hours when the dry-bulb temperatures are 55°F., or greater; humidity ratio; and enthalpy. These data were used to verify the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Weather Data and Design Conditions for Los Alamos. The winter design temperatures agreed very closely, but the ASHRAE summer dry-bulb and wet-bulb design temperatures were both high and, therefore, more conservative. The data indicate that the following are more nearly representative design temperatures for Los Alamos. Winter, dry-bulb: 3°F(99%); 8°F(97½%), summer, dry-bulb: 85.3°F(1%); 82.9°F(2½%); 80.5°F(5%), and summer, wet-bulb: 63.2°F(1%); 61.7°F(2½%); 60.5°F (5%). (These values are the temperatures above which the temperature was observed to be the percent of the time given.) (auth)

9262 (PNE–959) REPORT OF OFF-SITE SURVEILLANCE FOR PROJECT CABRIOLET. (Southwestern Radiological Health Lab., Las Vegas, Nev.). May 1971. 70p. Dep. NTIS.

Project Cabriolet was a 2.5-kt nuclear excavation experiment conducted at the Nevada Test Site on January 26, 1968, as part of the Plowshare program. The results of the off-site radiological surveillance program conducted for this event by the Public Health Service are presented. Aircraft and ground monitoring teams documented the radioactivity discharged to the atmosphere from this event as it traveled northward from the Nevada Test Site into southern Idaho, then north-eastward where it was detected as far as Big Timber, Montana. The highest external gamma exposure rate observed off-site was 65 mR/hr measured at Clark Station, Nevada, during cloud passage by a permanent exposure rate recorder. This is a populated location 61 miles from ground zero on an azimuth of 353°. The exposure at Clark Station for cloud passage plus seven days residual activity was 8 mR. The highest exposure from cloud passage in the off-site area as measured by thermoluminescent dosimeters was 12 mR two miles west of Clark Station. The highest integrated gross beta activity observed in air at a populated location was 560 $\mu Ci-sec/m^3$ at Stone Cabin Ranch, 65 miles from ground zero on an azimuth of 355°. This sample was collected during the cloud passage period from 1020 to 1500 PST, January 26. The highest ^{131}I concentration observed in milk was 630 pCi/l in a sample collected 14 days after the detonation at Mountain View Ranch near Wells, Nevada. No radioactivity was detected in milk or air samples collected beyond the northern Nevada border. Low levels of residual activity were detected in snow samples collected as far northeast as Big Timber, Montana. (auth)

9263 ^{85}Kr IN THE TROPOSPHERE. Schroeder, J. (Univ., Heidelberg); Muennich, K. O.; Enhalt, D. H. Nature (London); 233: No. 5322, 614-15(29 Oct 1971).

Measurements are reported of the ^{85}Kr activity in samples from air liquefaction plants at Oberhausen and Duisburg in Germany. All samples were analyzed more than four months after collection and therefore contributions from ^{133}Xe and ^{222}Rn could be neglected; other necessary corrections were made. The results are shown graphically and compared with earlier results. Increase in atmospheric ^{85}Kr activity during the past decade appears to be linear, at about 55 dpm/m mole/yr. With regard to the tropospheric burden of ^{85}Kr, it is estimated at 9.65×10^{26} atoms in 1969, with a total ^{85}Kr production of 1.36×10^{27} atoms, corresponding to fission of 182 tons of ^{235}U. (UK)

9264 CIRCLE OF INVESTIGATION OF AN AIR-BORNE GAMMA-RAY SPECTROMETER. Duval, Joe S. Jr.; Cook, Beverly; Adams, John A. S. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 76: No. 35, 8466-70(10 Dec 1971).

Calculations that will enable an experimenter to estimate the volume of material viewed by an airborne gamma spectrometer are presented. The effects of altitude, air density, source density, and gamma attenuation coefficient were investigated. It is shown that the altitude is the most important parameter in the determination of the volume of material that produces a given percentage of the total observed signal. (auth)

9265 WORLDWIDE DEPOSITION OF LONG-LIVED FISSION PRODUCTS FROM NUCLEAR EXPLOSIONS. Peirson, D. H. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London); 234: No. 5324, 79-80(12 Nov 1971).

The worldwide deposition of long-lived fission products is considered against the history of nuclear explosions. The present rate of deposition is much smaller than at the time of maximum fallout. The total amount deposited is consistent with the estimated amounts injected into the atmosphere. (auth)

9266 EFFECT OF THE RELIEF ON THE VERTICAL DISTRIBUTION OF NATURAL RADIOACTIVITY IN ATMOSPHERE. Chkhenkeli, Sh. M.; Golub, T. V. (Inst. of Geophysics, Erevan). Soobshch. Akad. Nauk Gruz. SSR; 63: No. 3, 593-6(Sep 1971). (In Russian).

Airborne radioactivity at the surface in Delisi is 1.5 to 2.7 times higher than that in Kojori, and their annual course is almost identical. The difference between the radioactivity ratio at Delisi–Kojori and in free atmosphere at the heights of 500 and 1500 meters equals 1.2. The latter value approximately characterizes the influence of relief on the normal decrease of natural radioactivity with height. (auth)

9267 OBSERVATIONS OF WIND PROFILE AT RESEARCH REACTOR INSTITUTE, KYOTO UNIVERSITY. II. Mizuma, Mitsuo; Iwamoto, Satoshi; Sano, Haruhiko; Takahashi, Takeshi. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 144-52(1971).

Data from double theodolite measurements of wind velocity and direction at varying heights above the Kyoto University Reactor site are presented, and methods for evaluating the errors in these measurements are presented. (L.C.L.)

9268 RADIOACTIVITY IN THE ATMOSPHERE OF PALERMO FOLLOWING A RECENT NUCLEAR EXPLOSION. Agelao, G.; Cappadona, C.; Greco, G.; Romano, M. C. (Univ., Palermo, Italy). Atti Accad. Sci. Lett. Palermo; 29: 223-30(1968-69). (In Italian).

The γ-ray spectra of the fallout following the Chinese test explosion of September 29, 1969 were measured. The 1.6-MeV peak of the ^{140}La activity was identified on October 22. Other nuclides produced in this explosion were also found. The fallout activity rose to a maximum on October 24 and the fallout lasted for ~10 days. (auth)

9269 RADIOACTIVITY OF THE ATMOSPHERE OVER CSSR DURING THE YEARS 1967 TO 1969. Santroch, Jaroslav; Kolarova, Hana. Radioisotopy; 11: No. 4, 599-614(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The radioactivity monitoring service of the Institute of Hydrometeorology has measured the atmospheric radioactivity since 1962. The measurements were carried out by 11 stations in the CSSR and their working program is described. The samples are processed, counted, and evaluated in Prague and in Bratislava. The processing and counting techniques are prescribed within the program of meteorological services of socialist countries. The national centers exchange their results so that a good survey of atmospheric radioactivity over Eastern Europe is possible. Results of measurements in the period between 1967 to 1969 are given. Spectrograms are given of samples from summer 1969, measured with a NaI(Tl) crystal and semiconductor Ge(Li) detector. A list of nuclear explosions from this period is added for reference. (auth)

9270 ROLE OF THE IONIZATION OF DIFFERENT GASES DURING THE FORMATION OF AEROSOLS CONTAINING RADON DECAY PRODUCTS. Styro, B.; Orlova, N. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana; 7: No. 3, 309-16(1971). (In Russian).

The stability of the complex molecules of Rn decay products in dry, filtered, ionized air was studied, and the role of the ionization of O_2, CO_2, and N_2 in the formation of ^{218}Po, ^{214}Pb, and ^{214}Bi

investigated. The results showed that the presence of EtOH, C_6H_6, naphthalene, and H_2O vapor decreases the activity of Rn-decay aerosols. The probable structures of these aerosols are discussed. (auth)

Mineralogy and Exploration

9271 URANIUM RESOURCES, PRODUCTION, AND DEMAND. Boxer, L. W. Combustion; 43: No. 6, 24-6(Dec 1971).

Estimates are presented on the low-cost reserves of U in the non-Communist world based on 1970 and 1971 data. Tabulated data on the energy content of the world's fossil fuels and known U resources are given. It is concluded that with adequate effort in the development of resources, low-cost U reserves may be expected to be sufficient until fast breeder reactors can assume a substantial share of electricity production from nuclear sources. (L.C.L.)

9272 DISTRIBUTION OF URANIUM AND THORIUM IN THE MALSBURG GRANITE. Barthel, F. (Bundesanstalt fuer Bodenforschung, Hanover); Mehnert, K. B. Neues Jahrb. Mineral., Abh.; 114: No. 1, 18-47(1970). (In German).

The Malsburg granite in the southern Black Forest, Germany, is relatively well known in its quantitative composition from a series of petrographic and geochemical investigations. The distribution of uranium and thorium in the main Malsburg granite and in its subsequent magmatic differentiation series has been investigated. Every group of rocks has a characteristic content of U and Th varying greatly from group to group. There was no evidence of a continuous increase or decrease of U and/or Th during the course of the differentiation process. A late magmatic potash feldspar metasomatism caused a decrease in both elements, especially in Th. This was probably due to a dilution effect in connection with the addition of potash feldspar. Postmagmatic changes of the U and Th contents, caused by hydrothermal processes or weathering, led to a decrease in both elements, especially in U. (INIS)

9273 MOBILITY OF URANIUM AND THORIUM IN GLASSY AND CRYSTALLIZED SILICIC VOLCANIC ROCKS. Rosholt, J. N. (Geological Survey, Denver); Prijana; Noble, D. C. Econ. Geol.; 66: No. 7, 1061-9(Nov 1971).

Analyses of hydrated and nonhydrated glass pairs from three welded ash-flow units and four lava flows of Tertiary age from the Western United States showed that the uranium and thorium contents of hydrated glass, when corrected for water hydration, were nearly identical to those of the parent nonhydrated glass. This indicates that no measurable quantities of uranium or thorium were removed from or added to the glass during or after hydration. The uranium content of nine crystallized specimens, however, was only 20 to 70 percent of that in the glasses from the same unit. These differences reflect a loss of uranium from the crystallized material by some combination of distillation as the volatile fluoride during cooling and crystallization and ground water leaching after cooling. The thorium content of primarily crystallized groundmass material was nearly the same as that in glasses from the same unit. The possibility appears remote that volcanic ash layers that have simply undergone hydration without devitrification have provided a large source of uranium in ore deposits in stratigraphically underlying sediments, such as in the intermountain basins in Wyoming. Comparison of the potential source of uranium available from granites in this area suggests that approximately 20 grams uranium per 1,000 kilograms of granitic rock may have been available, whereas, a maximum of about 5 grams uranium per 1,000 kilograms of original volcanic material could have been available if the volcanic ash devitrified. (auth)

9274 Th/U AND U/K RATIOS AS POSSIBLE AIDS IN PROSPECTING FOR URANIUM DEPOSITS IN PENINSULAR INDIA. Aswathanarayana, U. (Univ. of Saugar, Sagar, India). Econ. Geol.; 66: No. 7, 1078-80(Nov 1971).

The possibility of using Th/U, U/K, and Th/K ratios as aids in prospecting for the deposits of U in which India is presently deficient is discussed. From previous data it was concluded that the Th/K ratios do not appear to be capable of delineating either U-poor or U-rich areas in the Indian context. (16 references) (P.C.H.)

9275 SOME FEATURES OF THE FORMATION OF INCREASED URANIUM CONCENTRATIONS UNDER OXIDIZING CONDITIONS. Borkov, F. P.; Egorov, N. I.; Zaitsev, E. V. (Geological Prospecting Inst., Moscow). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 14: No. 5, 51-7(1971). (In Russian).

Many uranium deposits in sedimentary rocks are epigenetic, being formed by infiltration of underground waters. A geochemical barrier in the path of such penetration results in deposits of this type. Mineralized uranium is associated with crustal weathering of only Oligocene clays. Within limits of crustal weathering, the concentrations of uranium are marked into sections accessible to penetrating waters. In sections of ore manifestation, devoid of clay cover, the uranium concentrations gravitate to the upper parts of the oxidation zone. The richest uranium concentrations are noted where the crust of weathering has maximum vein width. In all probability, in sections where the zones of oxidation are not represented by wide veins, the uranium mineralization has been partially or completely destroyed by erosion. (K.S.W.)

9276 URANIUM MINERALIZATION NEAR SURDA IN THE SINGHBHUM COPPER BELT OF BIHAR (INDIA). Law, Y. D. Miner. Deposita; 5: No. 4, 390-5(1970).

A detailed study is reported of the uraniferous formations of a 2.5 km by 1 km portion of the Singhbhum copper belt near the village of Surda, India. The geology, different rock types, distribution of radioactivity, and features of the main uranium ore body, its reserves, and possible origin are summarized. A Geiger counter survey revealed that the most radioactive portions are in the mineralized shear zone along the western slopes of Surda ridge, in a zone east of the village of Chirudih, and in a small isolated hillock southwest of Surda composed of a tourmaline-apatite-quartz granulite with torbernite and autunite. The latter is the host rock for the main uranium orebody in the area. It is possible that these secondary uranium ores were leached by underground waters from primary minerals in a granitic stock below Surda and redeposited in the Surda Granulite. (Geophys. Abstr.)

9277 INFLUENCE OF MORPHOLOGY AND INTERNAL STRUCTURE OF VOLCANIC BODIES ON THE LOCALIZATION OF URANIUM–MOLYBDENUM MINERALIZATION. Lebedev-Zinov'ev, A. A.; Modnikov, I. S. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 14: No. 5, 58-64(1971). (In Russian).

Uranium ore regions are found in intrageoantisynclinal upheavals rendered complex by large-scale fracturing bucklings. Dimensions, morphology, and structure of volcanic bodies are determined by the geological development of the pertinent strata. Multiphase linear and isometric volcanic bodies of large-scale dimensions and heterogeneous structure are the most favorable for localization of manifold ore bodies according to their morphology. In bodies of an exposed type, veins of brecchia and cockade ore predominate, localizing on apical parts where a flat-dipping fissure structure has developed. (K.S.W.)

9278 CORRELATION BETWEEN U–Mo AND Sn–W–Mo HYDROTHERMAL MINERALIZATION. Modnikov, I. S.; Tarkhanova, G. A.; Chesnokov, L. V. Geol. Rud. Mestorozhd.; 13: No. 2, 92-7(May 1971). (In Russian).

The area of distribution in the transition zone between Caledonian and Hercynian folded regions was investigated. Deposits of Sn–W–Mo were coordinated with the fracture zone of a northwest strike and were distributed into endo- and exo-contact stages of apical ledges of leucocratic granites of the second intrusion complex. Deposits of U–Mo were also localized in fractures of a northwest strike, but were located in sub-volcanic bodies of felsite-porphyry, embedded in volcanogenic rock of the Devonian period. Multistaged formations characterize the U–Mo mineralization. The formation of higher temperature quartz-feldspar-fluorspar veins containing rare-metal mineralization occurs on the U–Mo deposits after localization of the basic U ore. (tr-auth)

9279 STUDY OF THE SANDS OF THE TOSCO-LAZIALE COASTLINE. GENERAL MINERALOGICAL COMPOSITION. DISTRIBUTION OF U AND Th IN THE NETTUNO SANDS. Brondi, Aldo; Ferretti, Ornella; Michetti, Italo; Sircana, Silvia (CNEN, Rome). Rend. Soc. Ital. Mineral. Petrol.; 27: 49-82 (1971). (In Italian). (RT/GEO–(71)6).

The sands of some tirrenic beaches were examined for their magnetite content and studied for their radioactivity in relation to the occurrence of thorium and uranium minerals such as monazite, thorite, zircon, perrierite, orthite, and others. The Italian Atomic Energy Commission (C.N.E.N.), which evaluates the Italian reserves of radioactive minerals, supervised the preceding works and carried out new searches. The results of both mineralogical and radiometric analyses show that much of the radioactivity is due to the main mineral components such as pyroxenes. The usual radioactive minerals are not present in concentrations that would be economical to exploit. (auth)

9280 CHARACTERISTICS OF DEVELOPMENT OF STRUCTURES CONTROLLING ENDOGENIC URANIUM DEPOSITS IN GRAVITATIONAL AND MAGNETIC FIELDS. Nazarov, M. P.;

Poluarshinov, G. P. At. Energ. (USSR); 31: No. 1, 60-1(Jul 1971). (In Russian).

Data are given on the presence of correlation bonds between elements of geological structures, which control uranium ore deposition, and the anomalies of magnetic and gravitational fields. The densities and magnetic susceptibilities of several types of rocks are tabulated for comparison. The two minerals syenodiorite (monzonite) and porphyrite possess high magnetic susceptibility in comparison to sedimentary rock. Intrusions of such minerals would show local anomalies in a magnetic survey. A typical map illustrates the metallogenic features: isomagnetic lines, magnetic field anomaly, and the relative location of an ore deposit. (K.S.W.)

9281 URANIUM DISTRIBUTION IN CLAY MINERALS IN AN OXIDATION ZONE. Rekharskaya, V. M. At. Energ. (USSR): 31: No. 1, 61-3(Jul 1971). (In Russian).

Argillaceous minerals with an increased U content in the zone of oxidation were examined chemically and physically. The data show that kaolinite and similar minerals collect U in the oxidation zone, and in such zones the most favored areas are those in which iron sulfide has been retained. (K.S.W.)

9282 ENERGY AND THE PRINCIPAL METALS AND ORES IN FRANCE AND FRENCH TERRITORIES OVERSEAS IN 1970. Ann. Mines; 23-4(Aug 1971). (In French).

The world U production (excluding China, the USSR, and eastern Europe) in 1970, was 17500 metric tons. This figure is made up as follows: USA: 9200 metric tons, Canada: 3000 metric tons, South Africa: 3000 metric tons, France: 1764 metric tons in the form of chemical concentrates. The various requirements are examined in relation to the different production capacities. The policies of the CEA in France and abroad in connection with prospecting, exploitation, and concentration are examined. French mines produced 530000 metric tons of ore in 1970, which yielded 1295 metric tons of U (1220 metric tons being extracted by the CEA and 75 metric tons being extracted by private enterprises). The costs of different U ores are given. (France)

Oceanography

9283 ^{14}C IN THE SOUTHERN OCEANS FROM NUCLEAR BOMBS. Fairhall, A. W.; Bradford, P.; Yang, I. C.; Young, A. W. (Univ. of Washington, Seattle). Antarctic J. U. S.; 6: No. 5, 163-4 (Sep-Oct 1971).

The program of water sampling for natural and bomb-produced radiocarbon in the southern oceans was continued. Approximately 200 water samples (60-liter) were collected and processed for their dissolved CO_2 (total inorganic C). The ^{14}C specific activity, corrected for isotope fractionation, was plotted as a function of depth at a number of locations. The Antarctic Circumpolar Water was characterized by ^{14}C levels of around 150% more or less independent of geographic location. Vigorous air-sea exchange of CO_2 at mid-latitudes, where winds are strong, was evidenced by the significant enrichment by bomb ^{14}C in the upper layers, 50% being a reasonable upper limit for natural ^{14}C levels of the surface layer at these latitudes. In some areas, bomb ^{14}C has enriched the surface layer by nearly 200%. The vigorous winds are also conducive to downward mixing of bomb ^{14}C added at the surface. (P.C.H.)

9284 ACCUMULATION OF ARTIFICIAL RADIONUCLIDES IN SHALLOW WATER DEPOSITS OF THE SOUTH ATLANTIC. Patin, S. A.; Tkachenko, V. N. At. Energ. (USSR); 31: No. 1, 72-4(Jul 1971). (In Russian).

Data on the artificial radioactivity in samples of sludge deposited in the southern Atlantic Ocean (off the eastern coast of South America) in 1967 to 1968 were obtained. Concentrations of $^{95}Zr-^{95}Nb$ and $^{106}Ru-^{106}Rh$ were recorded in pCi/kg of dried sediment. A tendency was observed for activity to decrease from north to south. (K.S.W.)

9285 CONTROL OF RADIOACTIVE POLLUTION IN INDIA. Pillai, K. C.; Kamath, P. R. (Bhabha Atomic Research Center, Bombay). Mar. Pollut. Bull.; 2: No. 5, 74-5(1971).

The National Center for Nuclear Research in Bombay has 3 research reactors and production plants for Th and U, a nuclear fuel fabrication facility, a fuel reprocessing plant, and radiochemical and isotope labs. The adjoining bay waters are used as a secondary coolant for the 40-MW natural U-heavy water reactor. Low-level radioactive liquid effluents originating from the center are released in the bay. Water movement studies began in 1957 with a systematic study of radioactive pollution in the region of environmental discharge and effected mostly by tidal transport and turbulent diffusion. Dilution factors of the order of 10^4 were obtained. Data on the concentrating mechanisms in the bay were obtained through stable element ratios (seafood to water) of products harvested from the bay. Extensive investigations were conducted on the bay sediments. Monitoring results over the last decade have shown that even in areas close to the discharge locations, the concentrations of ^{90}Sr and ^{137}Cs in sea waters are much below the permissible limits. Coastal bay waters normally contain heavy loads of silt which have high sorption capacity for radionuclides. Bottom sediments also showed high pickup ^{137}Cs, ^{144}Ce, and ^{106}Ru. Most accumulation was in the discharge area. The fish tissues and salt showed pickup of ^{137}Cs and ^{90}Sr, but the levels were very low compared to derived permissible limits. Pollution due to a power station at Tarapu is also discussed and experimental studies are reported. (auth)

Seismology

Refer also to abstract 9238.

9286 (CONF-711009-10) REVIEW OF THE GROUND MOTION PREDICTION PROBLEM FOR PLOWSHARE UNDERGROUND ENGINEERING APPLICATIONS. Hays, Walter W. (Environmental Research Corp., Las Vegas, Nev.). [1971]. 20p. Dep. NTIS.

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971).

Reliable descriptions of the ground motion expected from a Plowshare underground engineering detonation are necessary. They are required to estimate the nature of the forces that will develop in a structure as a consequence of the ground motion and to assess the potential hazard to people and property. The ground motion prediction methodology incorporates both empirical and theoretical analyses and has been developed in terms of the three critical elements of the total wave propagation systems; the SOURCE region; the TRANSMISSION path; and the RECORDING SITE geology. On an empirical basis, over 3,000 seismograms representing a range in epicentral distance of from 0.3 to about 350 miles and a dynamic range of from 10^{-5} to more than 1 g in peak particle acceleration have been analyzed. The statistical analyses have addressed the behavior of: peak amplitudes of particle acceleration, displacement, and velocity; response spectra; and wave forms; all as a function of energy release at the source, the source-to-recording site distance, and the local site geology. On a theoretical basis, mathematical models have been developed which give quantitative predictions of the effects of the source, transmission path, and site geology, in terms of measurable physical parameters. This predictive methodology has been validated by application to detonations at the Nevada Test Site, the Central Nevada Test Area, the Supplemental Test Site in Amchitka, and for Plowshare detonations in New Mexico (Gasbuggy) and Colorado (Rulison). The Plowshare experience, in particular, has shown that depth of burst, a source region parameter, has an important influence upon the spectral composition and the level of ground acceleration. Plowshare experience has also shown that the local near-surface geological configuration can significantly amplify the spectral components of the ground motion which correspond to the natural frequency of the layered sequence. Recognition and consideration of these effects are very important. Current Plowshare projects being developed (e.g., Rio Blanco and Wagon Wheel) are considering detonation of multiple devices. The effect on this parameter of the source region, which has not been a consideration for previous Plowshare experiments, is not well understood and is being actively studied. Preliminary consideration indicates that the spectral composition corresponding to the multiple shot detonation could be relatively richer in the shear wave energy spectral components. The uncertainty associated with a ground motion prediction in new geographic areas, candidates for underground engineering projects, requires careful definition and is also being studied currently. The ground motion prediction methodology is continuously developed and refined to insure adequate prediction of ground motion diagnostics for any Plowshare detonation. (auth)

9287 (JAB-99-81) SPECTRAL MATRIX METHOD OF PREDICTING DAMAGE FROM GROUND MOTION. Blume, John A.; Monroe, Robert E. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Sep 1971. Contract AT(26-1)-99. 90p. Dep. NTIS.

Many factors influence structure damage caused by ground motion generated by underground nuclear detonations or earthquakes; such factors include the number and type of structures exposed, the level of ground motion, and the capacity of structures to resist the motion. On a large scale it is necessary to

express the variables statistically and to predict damage levels based upon the joint statistical distribution of the individual variables. The Spectral Matrix Method (SMM) was devised to incorporate all relevant parameters in a unified prediction scheme which takes into account statistical variations of the individual factors. A discussion is presented of the SMM and its application in relation to past and current programs of the U. S. Atomic Energy Commission, Nevada Operations Office. (auth)

9288 (JAB-99-87) STATISTICAL CORRELATION OF OBSERVED GROUND MOTION WITH LOW-RISE BUILDING DAMAGE: PROJECT RULISON. Farhoomand, I.; Scholl, R. E. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Sep 1971. Contract AT(26-1)-99. 67p. (PNE-R-54). Dep. NTIS.

A statistical study was conducted using the observed ground motion and structure damage data obtained from Project Rulison. The statistical analysis leads to identifying the ground motion characterization which best represents the damage potential of ground motion for low-rise buildings. A statistical model for predicting damage is presented. This model relates ground motion intensity to three damage prediction parameters: number of complaints, percentage of buildings damaged, and damage repair cost. A simple procedure for the application of the model to practical cases is discussed. The vector of the two horizontal components of response spectrum acceleration was determined to best represent the damage potential of ground motion for low-rise buildings. (auth)

9289 (NVO-464-1) STRAIN MEASUREMENTS IN THE ALEUTIAN ISLANDS. Tocher, Don; Pfluke, John H.; Blackford, M. E. (National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Research Labs.). Oct 1971. 27p. GPO $0.35.

The equipment and methods used in carrying out the Aleutian Islands strain measurement program begun in 1969 for monitoring and interpreting the state of near-surface earth strains and tilts in the Aleutian Islands are described. Information is given on the tectonics of the Aleutian Islands, location and type and instruments used in the monitoring network, data obtained to mid-October 1970, and data analysis. (L.C.L.)

9290 (NVO-1163-230) OBSERVED GROUND MOTION DATA, CANNIKIN EVENT. West, Lewis R.; Christie, Raymond K. (Environmental Research Corp., Las Vegas, Nev.). Dec 1971. Contract AT(29-2)-1163. 30p. Dep. NTIS.

The results of the processing of the observed ground motion from the Cannikin Event, an underground nuclear detonation on Amchitka Island, at the United States Atomic Energy Commission's Supplemental Test Site "A" is presented. Ground motion data recorded at instrument stations deployed by the Earth Sciences Laboratory were processed and compiled. Pseudo-Relative Velocity Spectra at 5% damping were derived from the velocity seismograms. (auth)

9291 (UCRL-51097) CAVITY DECOUPLING OF NUCLEAR EXPLOSIONS. Rodean, Howard C. (California Univ., Livermore. Lawrence Radiation Lab.). 2 Aug 1971. Contract W-7405-eng-48. 33p. Dep. NTIS.

The physical phenomena of nuclear explosions in air and in rock are described, and it is shown that the more rapid inelastic stress-wave attenuation in air makes possible cavity decoupling. The mathematical theory of elastic-wave radiation is outlined, with emphasis on the frequency-dependence of the elastic-wave spectra on cavity geometry. Definitions are given for tamped, partially-decoupled and fully-decoupled explosions. Five different criteria for full decoupling are described; one is exact and the other four are approximations which are expressed in terms of simple mathematical formulas. One criterion is well known and probably conservative in practice, and another is recommended for use with cavities in strong salt (i.e., salt that has not been weakened by earlier explosions). The recommended criterion is that the post-explosion cavity pressure be equal to or less than the overburden pressure. The results of the Cowboy experiments with chemical explosions and the Sterling nuclear experiment, which demonstrated that cavity decoupling can reduce body-wave magnitude by about two magnitude units, are summarized. The advantages and disadvantages of spherical and nonspherical decoupling cavities are discussed, and it is shown that such cavities need not be spherical. Three methods of cavity construction are evaluated, with emphasis on construction in salt, the favored material. Conventional mining may be done in all types of rock, but solution mining is possible only in salt and experience indicates that nuclear-explosion construction is probably possible only in salt. Other construction constraints, such as cavity size and depth, are discussed. The Salmon cavity history demonstrates that cavities may be reused for decoupled explosions. A brief discussion of possible venting and cavity collapse to the surface is presented. It is concluded that cavity decoupling is a technically feasible evasion technique, with possible applications for nuclear explosion yields up to at least 50 kt. A comprehensive list of references is included. (auth)

9292 SURFACE WAVES FROM UNDERGROUND EXPLOSIONS. Marshall, P. D. (United Kingdom Atomic Energy Authority, Blacknest, Eng.); Douglas, A.; Hudson, J. A. Nature (London); 234: No. 5323, 8-9(5 Nov 1971).

Published data on the surface wave magnitude (M_s) and yield (Y) for underground explosions at test sites in N. America are discussed. It is stated to be clear that for explosions in consolidated rock all the observations lie close to the line $M_s = \log Y + 2.0$ for yields of 4 to 1,300 k ton. For explosions in unconsolidated rock the curve appears to be more like $M_s = \log Y + 1.0$, at least for yields ~100 k ton. Corrections are made on the curves shown for deviations of the source to receiver path from an average path, and for the effect of the path on the propagation of surface waves of different periods. It is concluded from the data list that if it is assumed that explosions at any location have been fired in consolidated rock, yields can usually be estimated to within a factor of two, which is a great improvement on routine calculations using body wave magnitude. (UK)

9293 RELATIVE EXCITATION OF SEISMIC SURFACE AND BODY WAVES BY POINT SOURCES. Douglas, A.; Hudson, J. A.; Kembhavi, V. K. Geophys. J. Roy. Astron. Soc.; 23: 451-60(1971).

Experimental evidence shows that earthquakes can be differentiated from explosions on teleseismic records by their relatively greater amplitude of Rayleigh waves compared with the amplitude of the direct P-wave; in effect the ratio of magnitude estimates m_b/M_s, is greater for explosions than for earthquake. The contribution of source mechanism alone to this effect is assessed. Point dilatation and double-couple sources are used to represent explosions and earthquakes and the amplitudes of the waves generated from such sources in a uniform half space are derived. The results show that source mechanism is an important factor governing the value of m_b/M_s. (auth)

9294 SHOCK WAVES AND THE MECHANICAL PROPERTIES OF SOLIDS. Proceedings of the 17th Sagamore Army Materials Research Conference Held at Raquette Lake, New York, September 1-4, 1970. Burke, John J.; Weiss, Volker (eds.). Sagamore Army Materials Research Conference Proceedings. Syracuse, N. Y.; Syracuse University Press (1971). 424p. $22.00. (CONF-700910).

Results of recent research is presented on propagation of high-intensity waves in metals, polymers, composites, porous materials, soils, and rocks. Information is also presented on models of dynamic fracture in solid materials. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 9264.

General Detectors and Monitors

Refer also to abstracts 8682, 8693, 9386, 9404, 9407, 9448, 9521, 9540, 9545, and 10115.

9295 (AD–719115) RADIAC CALIBRATOR. Materiel Test Procedure. (Army Test and Evaluation Command, Aberdeen Proving Ground, Md.). 21 May 1969. 9p. (MTP–8-2-64). NTIS.

The objective of the procedures outlined in the MTP is to provide methods for use in evaluating the technical performance of radiac calibrator systems relative to criteria contained in qualitative material requirements, small development requirements, or other applicable documents and determining their suitability for an intended use. (auth) (USGRDR)

9296 (AE–440) SELF-POWERED NEUTRON AND GAMMA DETECTORS FOR IN-CORE MEASUREMENTS. Strindehag, O. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov 1971. 17p. Dep. NTIS (U. S. Sales Only).

The performance of various types of self-powered neutron and gamma detectors intended for control and power distribution measurements in water cooled reactors is discussed. The self-powered detectors are compared with other types of in-core detectors and attention is paid to such properties as neutron and gamma sensitivity, high-temperature performance, burn-up rate and time of response. Also treated are the advantages and disadvantages of using gamma detector data for power distribution calculations instead of data from neutron detectors. With regard to neutron-sensitive detectors, results from several long-term experiments with vanadium and cobalt detectors are presented. The results include reliability and stability data for these two detector types and the ^{60}Co build-up in cobalt detectors. Experimental results which reveal the fast response of cobalt detectors are presented, and the use of cobalt detectors in reactor safety systems is discussed. Experience of the design and installation of complete flux probes, electronic units and data processing systems for power reactors is reported. The investigation of gamma-sensitive detectors includes detectors with emitters of lead, zirconium, magnesium and Inconel. Measured gamma sensitivities from calibrations both in a reactor and in a gamma cell are given, and the signal levels of self-powered neutron and gamma detectors when applied to power reactors are compared. (auth) (Sweden)

9297 (BARC–559) DETECTION AND MEASUREMENT OF ^{239}Pu IN WOUNDS. Sharma, R. C.; Somasundaram, S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 23p. Dep. NTIS (U. S. Sales Only).

A thin NaI(Tl) scintillation detector is optimized for the detection of soft x rays for use as a ^{239}Pu wound monitor. The resolution obtained for 17 keV x rays is between 60% and 65%. Typical spectra for x ray sources, e.g. ^{239}Pu, ^{109}Cd and ^{241}Am, are illustrated. Data on monitor sensitivity, background, minimum detectable ^{239}Pu activity and variation of the count rate in Pu channel with the depth of Pu source in a simulated human wound are presented. Corrections for the presence of radionuclides other than ^{239}Pu and self-absorption on ^{239}Pu assay are examined. Also examined is the effectiveness of Pu/Am photopeak count rate ratio of a typical thin source for the determination of source depth in a wound. (auth)

9298 (CONF-710705–7) RAPID METHOD OF MEASURING ENVIRONMENTAL RADIOACTIVITY USED IN THE USSR. Krisyuk, E. M.; Dolgirev, Ye. I.; Prokov'yev, O. N.; Shamov, V. P.; Artemenkova, L. V.; Isakov, L. M. [nd]. 15p. Dep. NTIS (U. S. Sales Only).

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

The basic methodology and instrumentation in use in the USSR for operational control of radioactive samples taken from the environment are discussed. The status of radiochemical methods of analysis, instruments and methods used in the laboratory, and field methods and apparatus are considered. Ion exchange columns and beta and gamma scintillation spectrometry are among the procedures treated. (R.W.R.)

9299 (CONF-710705–8) RAPID METHODS FOR THE ISOTOPIC ANALYSIS OF RADIOACTIVE ISOTOPES AND AEROSOLS. Artemenkova, L. V.; Kamyshchenko, V. D.; Kazankin, V. A.; Kurnoy, P. Ye.; Lapshin, V. I.; Malinin, O. A.; Nikitin, A. N. [nd]. 14p. Dep. NTIS (U. S. Sales Only).

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

Methods for determining the isotopic composition of aerosols and gases in air are described. It is possible to make a set of fairly simple instruments with which the components of a complex mixture of gases and aerosols can be identified fairly rapidly. The procedures discussed can be used for emergency determinations in nuclear installations and atomic power stations and for environmental monitoring in industrial and field situations. (R.W.R.)

9300 (IAE–2034) LITHIUM SCINTILLATING GLASSES FOR NEUTRON REGISTRATION. Orlov, N. F.; Andreeva, N. Z.; Gerasimov, V. F.; Zenkevich, V. S.; Moskalev, S. S. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 28p. (In Russian). INIS.

The effect of the composition and the melting conditions on the characteristics of lithium magnesium silicate scintillating glass for neutron registration was studied. The method is described and the results of the measurement of the characteristics of the glass scintillators are reported. Glass samples were obtained with light yields of ~16% with respect to anthracene. (tr-auth)

9301 (ICRU–20) RADIATION PROTECTION INSTRUMENTATION AND ITS APPLICATION. (International Commission on Radiation Units and Measurements, Washington, D. C.). 1 Oct 1971. 60p. ICRU, Washington, D. C. $3.50.

A basic discussion of radiation quantities and units, the interpretation of instrument readings in terms of such units, and the accuracy usually required is presented. Instrument characteristics for ionization chambers, gas proportional counters, G–M counters, scintillation counters, photographic devices, and solid state and activation devices are discussed. The choice and use of instruments for surveying, area monitoring, and environmental monitoring, particularly, sealed gamma-ray sources, sources of x rays and electrons; unsealed sources; reactors and sealed neutron sources; and accelerators are discussed. Also, the choice and use of instruments for individual monitoring are considered. The calibration of instruments is discussed, and data on thermal neutron instruments and dose equivalent instruments are presented. (W.H.K.)

9302 (JINR–P13-6078) NOISE-IMMUNITY OF THE MULTIPLEX SYSTEMS OF PARTICLE DETECTION AND THE METHODS OF REDUCTION OF THE MULTIPLICATIVE NOISES. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The two methods of decreasing the multiplicative random noise are outlined. The first method consists of the simultaneous measurements by the multiplex Hadamard system and by the traditional one. The equations which couple the function to be measured with the random noise are developed, and solutions are found with the help of the discrete Fourier transform. The information properties of the discrete Fourier transform of the convolution kernel which accomplishes the discrete Hadamard coding on the stage of the measurements are given. Simulated examples are shown in the form of the intermediate results of the measurements. The second method is the net Hadamard multiplex one. It can be used in the cases when the noises in the first method are mutually independent. The function to be measured can be found only within the corridor of errors. The difference between these two methods is analyzed. The parameter which permits one to find the optimal conditions of observation depends on the statistical covariance elements of the total variance. The ratio of the variances for two methods of the multiplicative random noise reduction is given. The simulated examples shown for the net multiplex system illustrate the potentialities of the Hadamard transform multiplex coding with reference to the noise-immunity. (auth)

9303 (KFKI–71-50) SCINTILLATION DETECTOR BACKGROUND. Andrasi, Andor; Beleznay, Ferencne (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 19p. (In Hungarian). Dep. NTIS (U. S. Sales Only).

The possibility of measuring very low activities (several pCi) with scintillation detectors is limited by the self-background within the scintillator shielding case. This background radiation is due to the presence of natural radioactive impurities in the scintillation crystal and in the structural materials of the photomultiplier. A measurement method for separating the background spectrum

components arising from these two sources is described. The results obtainable with this method promise to be of use in finding ways of reducing such background. (auth)

9304 (LBL-398) LAMINOGRAPHIC EXCITATION CAMERA FOR THYROID IMAGING. Kaufman, Leon; Perez-Mendez, Victor; Powell, Malcolm; Stoker, Gerald (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1971. Contract W-7405-eng-48. 13p. (CONF-711111-27). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A camera for the laminographic imaging of the thyroid without administration of radiopharmaceuticals to the patient is described. An external source of gamma-rays is used to excite the characteristic x-rays of natural iodine in the patient's thyroid, source geometry limiting excitation to well-defined planes. The camera consists of a parallel hole collimator and a xenon-filled proportional wire chamber with digitized readout of coordinates. Pulse height selection is provided to limit events in the image display to a selected energy range. It is estimated that the system will obtain high resolution laminography for local exposures on the order of 1 to 5 rad, with exposure times of a few minutes for each laminogram. (auth)

9305 (NRC-TT-1494) UTILIZATION OF THE $(\beta^+\gamma^\pm)$ COINCIDENCES IN THE INVESTIGATION OF POSITRON NUCLEAR DECAY. Vatai, E. Translated by H. R. Hayes (National Research Council of Canada, Ottawa), from Acta Phys. Acad. Sci. Hung.; 23: No. 4, 381-92(1967). 18p. Dep. NTIS (U. S. Sales Only).

A detailed analysis is made of the feasibility of utilizing the $(\beta^+\gamma^\pm)$ coincidence method to determine the efficiency of the (S_{β^+}) positron detectors, and by means of this to determine the activity of preparations which emit positrons. Such an analysis is necessary since annihilation quanta originate in a specific volume, and in this case it is not possible to use the formula for a point source. Possible methods of estimating or reducing the influence of the volumetric distribution of annihilation include: (1) numerical integration; and (2) increasing the distance between the source and the annihilation quanta detector, the use of β absorber, or utilization of a detection efficiency S_{β^+} close to 100%. The proper selection of measuring conditions makes it possible to reduce to less than 10^{-3} the effect which the volumetric distribution of the annihilation points has on the accuracy of determining the efficiency of (S_{β^+}) positron monitoring. (auth)

9306 (ORNL-TM-3474) DEVELOPMENT OF A GAMMA IONIZATION CHAMBER FOR THE OFFICE OF CIVIL DEFENSE. Clay, W. T. (Oak Ridge National Lab., Tenn.). Jan 1972. 15p. Dep. NTIS.

Two ionization chambers (ORNL model Q-5043) were developed for the OCD to be used in their radiological environmental monitoring systems. The chambers have an effective volume (air equivalent) of 450 and 1000 cc to cover the dose rate range from 0.1 to 10^4 R/hr. Physically both chambers are identical; only the gas mixture (N_2 and Ar) and total pressure are varied for proper energy response and sensitivity. The energy response of both chambers is flat (5%) from 70 keV to 1.3 MeV. The response for the top and side of the chamber, over this energy range, was within 2%. An internal beta source is used for calibration. (auth)

9307 (RT/PROT-(71)28) CALCULATION OF THE ESCAPE PEAK FOR A Ge(Li) AND A NaI X-RAY RADIATION DETECTOR. Fioratti, M. Paganini; Piermattei, S. Ricci (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 16 Jul 1971. 24p. (In Italian). Dep. NTIS (U. S. Sales Only).

The results are reported of the ratio, R, of the escape peak to photopeak photons for the Ge-Li detector. The calculations have been carried out according to the procedure adopted by Axel for NaI detectors and using the most recent determination of the parameters involved. The energy of the incident photons at which the ratio R is still effective is around 60 keV. The theoretical results are compared with those evaluated experimentally from other authors and the agreement is rather satisfactory. The calculations have been repeated for a NaI detector using the new data on the energy absorption coefficient of iodine and the fluorescence yield given by W. H. McMaster and R. W. Fink respectively. Also, a comparison has been made with the experimental results. (auth)

9308 (STI/DOC-10/133) HANDBOOK ON CALIBRATION OF RADIATION PROTECTION MONITORING INSTRUMENTS. (International Atomic Energy Agency, Vienna (Austria)). Nov 1971. 95p. IAEA $3.00.

A guide for establishing or operating calibration facilities for radiation monitoring instruments is presented. Topics include requirements of a calibration laboratory and the techniques to be used, calibration facilities, errors and quality control, and instrument maintenance and repair. Presented in the appendixes is a list of primary standard laboratories, a USSR State Standard for checking instruments for monitoring gamma exposures at 0.2 to 1.5 MeV, and a description of a typical laboratory building and staff. (132 references). (W.H.K.)

9309 (UARAEE-115) HIGH LEVEL NONOVERLOAD PULSE AMPLIFIER FOR NUCLEAR MEASUREMENTS. Hanna, Nabil N. (Atomic Energy Establishment, Cairo (Egypt). Engineering and Scientific Instruments Dept.). 1971. 28p. Dep. NTIS (U. S. Sales Only).

A nonoverload high level pulse amplifier designed for use with fast ionization chambers and proportional and scintillation counters is described. The amplifier can amplify linearly, either positive or negative pulses of amplitudes up to 10 V. The amplifier will deliver a positive going output pulse over the range 0 to 150 V with a nonlinearity of less than 1%. Saturation occurs at an output pulse height on the order of 180 V. The amplifier can handle, at its maximum gain setting, input pulses of height up to 20 V without overloading. The upper half frequency of the amplifier is of the order of 3 MHz and the long and short term gain stability is approximately 1%. Pulse shaping and discrimination level facilities are incorporated which make the amplifier particularly useful for coincidence work and counting in the presence of a high background. The instrument has been used for more than twelve months and has proved to be reliable. (auth)

9310 (UCRL-20840) ADAPTATION OF MULTI-WIRE PROPORTIONAL CHAMBERS WITH DELAY-LINE READOUTS FOR NEUTRON RADIOGRAPHIC IMAGING. Valentine, Kenneth; Kaplan, Selig; Kaufman, Leon; Perez-Mendez, Victor (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971. Contract W-7405-eng-48. 5p. (CONF-711111-28). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A proportional chamber employing delay-line readout has been adapted for thermal-neutron imaging through the use of a boron converter plate as one of the chamber electrodes. A small prototype chamber using natural B for a converter has achieved 0.5% thermal-neutron-detection efficiency and better than 2 mm resolution (10% to 90% knife-edge). A converter-plate-model calculation gives good agreement with the measurements and shows how efficiency and resolution vary with chamber thickness, energy discrimination, and B and Al-overcoating thicknesses. Substitution of ^{10}B for the natural B would give a five-fold increase in efficiency and the calculations indicate that a further improvement in both efficiency and resolution of up to 50% is achievable in a single-plate system. The results of these calculations and a comparison with measurements are presented. (auth)

9311 (UCRL-51131) RECENT TECHNIQUES IN TRITIUM MONITORING BY PROPORTIONAL COUNTERS. Block, S.; Hodgekins, D.; Barlow, O. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Oct 1971. Contract W-7405-eng-48. 21p. Dep. NTIS.

Proportional counters have recently been introduced as portable tritium monitors. Some techniques developed at LLL using proportional counters for monitoring tritium in air, in surface contamination, and in urine are described. Relative sensitivities and merits of this method are compared to ionization chambers and scintillation counting techniques. (auth)

9312 NEUTRON FLUX MEASUREMENT CHAIN BY MEANS OF A FISSION CHAMBER. Iftode, I.; Vasilescu, M.; Boeriu, St.; Tiron, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 6, 647-9(1971). (In French).

The preliminary results obtained with a neutron measurement chain designed to be used in a numerical control system of a reactor are presented. The neutron flux measurement is made with the use of a fission chamber as transducer connected to the pulse electronic system by the intermediary of a coaxial cable. The preliminary measurements had the purpose of establishing qualitatively the characteristics of the measurement chain. The total discrimination curve for the feed HT = 600 V, the saturation curve, and the linearity were established. (J.S.R.)

9313 INFLUENCE OF HIGHER RESONANCES DURING ACTIVATION MEASUREMENTS. Ilieva, K.; Khristov, V. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 175-84(1971). (In Russian).

The resonance self-shielding for 13 activation detectors, used during neutron spectroscopic investigations, is calculated. Correction factors are obtained which show the influence of the higher resonances on the coefficient of self-shielding for single plates, covered with cadmium, used in measurements by the Cd-ratio

method. Correction factors for the method of "sandwiches" are obtained showing the influence of the higher resonances on the activation realized by the major resonance for these detectors. It is shown that, by the method of "sandwiches", the influence of the higher resonances can be decreased if a parameter $\beta_1 = \Sigma_0 t = 1.5$ is used for an isotropic flux and parameter $\beta_1 \leq 2.5$ for a collimated flux. (auth)

9314 RECORDING AND MONITORING OF NEUTRON FLUXES BY MEANS OF FISSION-FRAGMENT GLASS DETECTORS. Kashukeev, N.; Ribarov, S.; Neova, I.; Taneva, T.; Todorov, N. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 247-58(1971). (In Bulgarian).

The effects of the time of development, density of tracks, and the developer concentration and temperature on the variation of the optical density of fission-fragment glass detectors, irradiated by neutrons, are investigated. On the basis of these investigations the optimal conditions for obtaining visual images of neutron fluxes on glass and the conditions under which these images may be used for the purposes of the neutron dosimetry are determined. (auth)

9315 DETECTION EFFICIENCY OF CHANNEL PLATES TO X-RAYS. Adams, J.; Millar, I. C. P. (Mullard Research Labs., Redhill, Eng.). Acta Electron.; 14: No. 2, 237-44(Apr 1971). (In French and English).

Arrays of channel electron multipliers (channel plates) are sensitive to many forms of excitation, either as electrically charged particles or as electromagnetic radiation. The response of channel plates to x-rays in the energy range 200 eV to 100 keV are discussed. Experimental and theoretical results indicate that channel plates have x-ray detection efficiencies which are potentially useful in scientific and industrial applications. (France)

9316 DETECTION OF HIGH ENERGY ELECTRONS. Chalmeton, V. (Laboratoires d'Electronique et de Physique Appliquee, Limeil-Brevannes, France). Acta Electron.; 14: No. 2, 225-36(Apr 1971). (In French and English).

Experiments designed to measure the detection efficiency of microchannel plates for electrons with energies between about 2 keV and 150 keV are described. Two electron sources were used: a pellet of ^{14}C and an electron gun. The variations in the detection efficiency with the gain of the channel plate and the electron energy were studied for different channel plates. (France)

9317 SPACE APPLICATIONS OF SINGLE CHANNEL ELECTRON MULTIPLIERS. Timothy, A. F.; Timothy, J. G. (University Coll., London). Acta Electron.; 14: No. 2, 159-79(Apr 1971).

The scientific aims of space experiments designed to study ultraviolet and x-ray spectra and low-energy charged-particle distributions are reviewed; and the difficulties of operation on sounding rockets, orbital satellites and deep-space probes are described. The single-channel electron multiplier is shown to be superior to other types of open structure multiplier, particularly for sounding rocket applications. The known parameters of the fatigue effects observed in open structure multipliers, operating under ultrahigh vacuum on satellites and deep space probes, are described; and the need for further laboratory studies aimed at producing stable low-noise multipliers is emphasized. (France)

9318 SOME APPLICATIONS OF SINGLE CHANNEL MULTIPLIERS. Petley, C. H. (Mullard Ltd., Mitcham, Eng.); Pook, R. Acta Electron.; 14: No. 2, 151-7(Apr 1971).

Mullard channel electron multipliers were used in 1967 to determine the position of the source of the electrons that are present during an auroral display. Since that time they have been employed as detectors in many other rocket and satellite based experiments. This application is reviewed. Some of their uses in laboratory experiments and industrial instruments are also indicated. (France)

9319 METHOD OF DETERMINING THE ENERGY OF X OR γ RADIATION AND A DEVICE EMPLOYING THIS METHOD. Martinelli, Pierre (to Commissariat a l'Energie Atomique). French Patent 2,054,428. 23 Apr 1971. Filed 28 Mar 1969. (In French).

A method of determining the energy of x or γ radiation is described. The method involves Compton scattering by at least one material and subsequent discrimination in terms of wavelength. The energy of the radiation is measured simultaneously with the angles corresponding to the incident (whose energy is to be measured) and the detected scattered beams. An apparatus utilizing this method is described. (France)

9320 METROLOGY OF RADIATION FIELDS IN VIEW OF SAFETY CONSIDERATIONS. Bricka, M.; Dolias, M.; Nguyen Van Dat (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 69-73(Apr 1971). (In French).

Neutron metrology apparatus has been developed by the SESR (Service d'Etudes de Surete Radiologique) safety studies group for radiation measurements in large nuclear plants. It consists of a multisphere spectrometer for measurements under normal working conditions (millirem level) and an activation integrating spectrometer for measurements in the case of an accident (several rems). A simple data reduction method (the model spectra method) is used to treat the problem; an even simpler method using linear functions from the data can be used. Classical methods are used for γ ray measurements (Li-Sn Geiger-Muller tube for dose rate measurements and radiophotoluminescent glasses for integral measurements). (France)

9321 MINIATURE FISSION CHAMBERS FOR MEASURING FISSION RATES IN RESEARCH REACTORS. Guery, M.; Jarrige, A. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Phys. Appl.: 6: No. 2, 121-7(Jun 1971). (In French).

Some recent developments are described: small diameter chambers, low absorption chambers, and high temperature chambers. The applications are briefly surveyed. (France)

9322 AUTOMATIC LIQUID SCINTILLATION COUNTING EQUIPMENT. (to Nuclear-Chicago Corp.). British Patent 1,252,971. 10 Nov 1971. Priority date 8 Feb 1968, United States.

The automatic liquid scintillation counting system described includes a chamber with liquid scintillator and photomultiplier, sample changing apparatus, sample counting circuitry, external standardizing apparatus, control apparatus, a reference source, reference source positioning apparatus, gain standardization circuitry, and sample efficiency calibration means. The external standardizing apparatus includes a standardizing source, external standardization circuitry, and source positioning apparatus for producing an efficiency-correction count. The control apparatus defines successive counting and standardizing periods during which no substantial gain changes occur. The sample efficiency calibration means produce an efficiency-corrected scintillation count. The apparatus described can be used, for example, to measure vials containing liquid scintillator and the beta-emitting substance to be counted. (R.W.R.)

9323 SPARK CHAMBER AS A DETECTOR FOR POSITRON ANGULAR CORRELATION MEASUREMENTS. Howells, M. R.; Osmon, P. E. (London Univ.). J. Phys., E (London): 4: No. 12, 929-35(Dec 1971).

A new kind of apparatus is described for making positron-annihilation angular-correlation measurements. The use of a spark chamber as a two-dimensional γ-ray detector enables two components of the momentum of photon pairs to be determined instead of the normal one. The development and construction of the special narrow gap spark chambers needed for this work are described, and a discussion of the spark mechanism of narrow gap chambers is given. The use of television cameras to read out the spark chamber information is then considered, and the logic of the complete recording system is briefly described. This apparatus was used to study a copper single crystal, and the effect of the "necks" of the copper Fermi surface was visible in the data. Various possible ways to improve the performance of the apparatus are then discussed. (auth)

9324 X-RAY DETECTORS WITH BANDPASS RESPONSE CHARACTERISTICS. Lindsey, James S. (Univ. of California, Livermore). Rev. Sci. Instrum.; 42: No. 12, 1870-2(Dec 1971).

A detector that is sensitive to x rays in only a given energy range is described. It can be constructed to have a wide variety of passband widths and positions. It has a very low sensitivity (roughly 10^{-21} C/keV of incident energy) and is, therefore, useful in high flux applications and where nanosecond time resolution is important. (auth)

9325 DETERMINATION OF THE EFFICIENCY OF NTB NUCLEAR TRACK EMULSION FOR THE DETECTION OF TRITIUM. Wheeler, K. T. Jr.; Shaw, E. I. (Univ. of Kansas, Lawrence). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 759-65(Dec 1971).

Calibration of pieces of ^3H-polymethylmethacrylate was accomplished by a routine liquid scintillation counting method. The detection efficiency of NTB liquid nuclear track emulsion for tritium beta particles was determined. The emulsion sensitivity was found to change over the first 4 days for most of the emulsion batches. The grain production was linear from day 4 to 14. The response of the emulsion was constant for bottles with the same batch number, but sometimes varied significantly between batches. The rate of latent image fading was determined for the conditions existing in the laboratory. A theoretical calculation of the rate of

grain formation in the NTB emulsion was made using the values derived from these techniques and was compared with the experimental results. These techniques described can be applied to many quantitative autoradiography situations which may be found in other laboratories. (auth)

9326 PROCESS FOR CONCENTRATING AND CONTROLLING THE RADIOACTIVITY OF WATER. Debrie, Guy; Dieval, Michel (to Commissariat a l'Energie Atomique). French Patent 1,603,021. 15 Mar 1971. Filed 7 Jun 1968. (In French).

A process for concentrating and controlling the radioactivity of water, particularly applicable to the liquid effluents discharged by nuclear plants, is described. The process involves electrolytically trapping the radionuclides, either in the electrochemical cell or by decanting prior to radioactivity measurements. It is suitable for detecting radionuclides at concentrations less than 10^{-7} Ci/m^3, the time constant between the flow of the contaminant into the detecting system and the triggering of an alarm being of the order of a few minutes. This method has a much greater sensitivity than those previously used. (France)

9327 APPARATUS FOR EXAMINING RADIO-ACTIVE COMPOSITIONS. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,238,906. 14 Jul 1971. Priority date 2 Sep 1967, Netherlands.

Apparatus for counting containers of radioactive substances is described; these substances may be mixed with a scintillator liquid. The device consists of a number of holders, each of which carries several containers. The holders, and the containers within the holders, are automatically and sequentially advanced past a counter to permit counting of any radioactivity present. (R.W.R.)

9328 METHOD AND APPARATUS FOR MONITORING A GASEOUS ATMOSPHERE FOR RADIOACTIVE ISOTOPES INCLUDING ORGANIC IODINE COMPOUNDS. Holford, Richard Moore U. S. Patent 3,590,247. 29 Jun 1971. Priority date 19 Aug 1968, Canada.

Air near, for example, a nuclear reactor is monitored for radioactive isotopes including organic iodine compounds by adding a trace addition of fluorine, chlorine, or bromine so that the isotopes will be absorbed by a charcoal-loaded filter paper. The filter paper is then analyzed for radioactivity. (auth)

9329 IMPROVED RADIATION DETECTOR. (to Babcock and Wilcox Co.). British Patent 1,243,488. 18 Aug 1971. Priority date 1 Aug 1969, United States.

An improved solid-state radiation detector that is suitable for extended in-core use as a local power level monitor is described. This detector can monitor the neutron flux and/or the combined neutron and γ flux intensities existing at a given localized region within the core of a reactor; its output signal represents the instantaneous value of the radiation sensed. The specific improvement of this detector is an emitter made of Hf or Yb. The delayed electrons emitted from these materials have a lower energy than the prompt electrons: they can, therefore, be absorbed so that the entire output signal is due to the prompt electrons and this represents the instantaneous radiation level. (R.W.R.)

9330 SENSITIVITY THRESHOLD OF PHOTOMULTIPLIERS FOR SCINTILLATION MEASUREMENTS OF SOFT BETA RADIATION. Gorin, V. V.; Zgurskii, V. A.; Strakovskaya, R. Ya. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 6, 910-12(Jun 1971). Translated from Izmer. Tekh.; 14: No. 6, 68-9(Jun 1971).

The sensitivity threshold or equivalent noise power is suggested as a criterion of photomultiplier quality for use in liquid scintillation counters for measuring the activity of low-energy beta sources. (W.H.D.)

9331 15th NUCLEAR SCIENCE SYMPOSIUM, MONTREAL, CANADA, OCTOBER 23-25, 1968. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 1-439(Feb 1969). (CONF-681017).

Separate abstracts were prepared for 49 of the 66 papers presented. Ten papers were previously included in NSA, and seven papers were outside the scope of NSA. For abstracts of the papers previously in NSA see CONF-681017 in a cumulative Report Number Index. (W.H.K.)

For abstracts of individual papers see: 9332-9345, 9362-9367, 9378-9381, 9436-9444, 9452, 10708-10712, 11338, 11339, 11341-11343, 11361, 11398, 11399, 11407, and 11408.

9332 LINEARITY AND RESOLUTION OF SEMICONDUCTOR RADIATION DETECTORS. Zulliger, H. R.; Middleman, L. M.; Aitken, D. W. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 47-61(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The energy linearity for Si(Li) and Ge(Li) has been measured and compared with theory. Good agreement was obtained for x-ray attenuation factors $\mu_m d < 100$. The region of the germanium absorption edge was investigated and found to exhibit larger nonlinearities than predicted by the theory. The discrepancy is believed to be due to inefficient charge collection near the detector window leading to excessive fluctuations in the trapped charge. Calculations of the line broadening due to trapping have been shown to agree qualitatively with experimental values for the silicon detector. These calculations do not take into account any position dependent variation of the trapping factor, and must therefore be considered as the best attainable values. The disagreement between theory and experiment for the line broadening in Ge(Li) is particularly evident. The ϵ seems to be independent of energy in Si to less than 0.2% and in Ge to within at least 2%. Finally the Fano factor in Si was found to be $0.154^{+0.01}_{-0.02}$. (auth)

9333 FURTHER CHARGE COLLECTION STUDIES IN COAXIAL Ge(Li) DETECTORS. Sakai, Eiji; McMath, T. A.; Franks, R. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 68-74(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Calculations have shown that, for comparable trapping lifetimes, the effect of charge trapping in a coaxial detector is significantly less for the carriers which move radially outward from the core than for those which move inward, as a consequence of the nonuniform electric field. This has been verified by resolution measurements on two thin coaxial detectors made from the same hole-trapping crystal; one was made conventionally, by drifting lithium in from the outer surface, the other in an "inside out" configuration by drifting lithium outward from the surface of a central hole. (auth)

9334 DETECTION OF LOW ENERGY HEAVY PARTICLES WITH SILICON BARRIER DETECTORS. Ray, J. A.; Barnett, C. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 82-6(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The performance characteristics of silicon surface barrier detectors have been investigated for detecting H^+, He^+, N^+, Ne^+ and Ar^+ in the energy interval 6 to 100 keV. For a cryogenically cooled, 50 mm^2, 1325 μ depletion depth detector the resolution for protons was 1.65 keV (FWHM). The resolution decreased as the particle mass increased being 6.5 keV for 40 keV Ar^+. All particles exhibit pulse height linearity throughout the energy range. (auth)

9335 COMPARISON OF VARIOUS FILTER AND DISCRIMINATOR TECHNIQUES ON TIMING WITH Ge(Li) DETECTORS. Douglass, T. D.; Williams, C. W. (ORTEC, Inc., Oak Ridge, Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 87-91(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

An experimental examination of the effect of several filters and two discriminator techniques on the time measurement of the signals from coaxial Ge(Li) detectors is presented. The signal to the filters and discriminators was obtained from the output of the charge-sensitive preamplifier in order not to degrade the energy resolution of the system. The discriminators used were a level discriminator for leading-edge discrimination and a fast zero-crossing discriminator. The filters examined for leading-edge discrimination were four RC time-invariant and four RC time-variant filters, and the filters for zero-crossing discrimination were three time-invariant RC filters. A comparison of time-invariant and time-variant filters reveals two advantages of the time-variant filter. These advantages are smaller timing errors and lower discrimination levels. The lower discrimination levels allow the reduction of energy dependent timing errors. Likewise, zero-crossing discrimination provides several improvements over leading-edge discrimination. By a compensation method, timing errors due to charge collection variations are reduced, and, due to the invariancy of the zero-crossing point as a function of amplitude, energy-dependent timing errors are also reduced. (auth)

9336 CALIBRATION OF THE SELF-POWERED NEUTRON FLUX MONITOR IN A SIMULATED PWR LATTICE. Baldwin, M. N.; Rogers, J. E. (Babcock and Wilcox Co., Lynchburg, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 171-6(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The response of a rhodium all-solid, self-powered incore monitor was measured in a critical assembly mock-up of a typical PWR. The detector signal strength and the power density of adjacent fuel rods were correlated. The detector background, typically 2 to 5%, was highly dependent on the detector environment as well as the incident gamma flux. (auth)

9337 TEST OF SIX HIGH TEMPERATURE NEUTRON DETECTORS TO 650°C. Bacastow, J. L.; Swickard, E. O. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 177-83(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Two neutron detectors (fission counters) from each of three manufacturers were tested at several temperatures between ambient and 650°C. Parameters examined as a function of temperature were: leakage current, capacitance, noise vs. voltage, and pulse height distribution. (auth)

9338 AUTOMATIC GAIN CONTROL FOR RADIATION DETECTION SYSTEMS. Gilland, J. R. (Ball Brothers Research Corp., Boulder, Colo.); Ried, L. Jr. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 277-82(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A simple automatic control system capable of compensating for detector gain changes over a dynamic range of 10 has been developed for laboratory and aerospace radiation detection systems. The basic concept involves a feedback system that adjusts the system gain to keep the peak of a stable calibration source at a predetermined level. Two variations are described, one providing continuous calibration and the other calibrating on command. The effects of calibration source characteristics and critical circuit parameters on the total system accuracy are discussed. Typical results for a proportional counter X-ray spectrometer indicate that the system gain can be maintained to within 4 percent of its initial value for a detector gain degradation of a factor of 3. (auth)

9339 LOW-ENERGY CHANNEL-MULTIPLIER SPECTROMETER FOR ATS-E. Reed, R. D.; Shelley, E. G.; Bakke, J. C.; Sanders, T. C.; McDaniel, J. D. (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 359-70(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A compact channel-multiplier instrument has been designed and developed for spectral analysis of low-energy (0.5 to 500 keV) electrons and protons at synchronous altitude on the ATS-E satellite. The instrument package, which weighs 1.3 kg, contains 11 sensors and features a completely automatic in-flight calibration system for the interrogation of sensor and electronic performance. A detailed discussion of experimental objectives and design and calibration data for the instrument is presented. The result of studies of the long-term behavior of channel-multipliers is emphasized. (auth)

9340 SPIRALTRON MATRICES AS WINDOWLESS PHOTON DETECTORS FOR SOFT X-RAY AND EXTREME UV. Somer, T. A.; Graves, P. W. (Bendix Research Labs., Southfield, Mich.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 376-80(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The principal problems associated with detecting low energy photons and charged particles are summarized, and the potential advantages to be gained by using channel electron multipliers to detect such radiation are discussed. Operating characteristics of the recently developed Spiraltron electron multiplier are also described. Spiraltrons incorporate all the operating characteristics of curved channel electron multipliers, but possess a straight geometric configuration that allows them to be stacked into large matrices. Such matrices have a peaked gain distribution (FWHM ≈ 90 percent), high mean gain ($\approx 10^7$), and low dark noise (3 counts/second/cm^2) making them ideal for detecting low energy radiation from spacially dispersed sources. (auth)

9341 PSEUDO-RANDOM PULSES FOR CALIBRATION OF NUCLEAR INSTRUMENTS. Holford, R. M. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 386-91(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A series of digital modules have been constructed which convert the equispaced output of a pulse generator into a pseudorandom sequence of predictable mean count-rate suitable for the calibration of nuclear instruments sensitive to the time-distribution of the input pulses. (auth)

9342 DESIGN OF PULSE PEAK STRETCHERS. Casoli, P.; Manfredi, P. F. (Inst. of Nuclear Engineering, Milan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 392-7(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The design of feedback peak stretchers for ensuring both linearity and absolute accuracy as well as a fairly low degree of sensitivity to the input shape is discussed. A preliminary discussion on the limitations of the blocks which constitute the feedback loop of the stretcher is followed by suggestions for their realization. The conclusions of a short theoretical analysis are summarized for an easier choice of the proper solution according to the various applications. Finally, different schemes of stretchers are given, which are believed to satisfy most practical needs, and the results of the experimental tests are shown. (auth)

9343 PROPANE BUBBLE CHAMBER AS A LOW LEVEL COUNTER FOR TRITIUM AND ^{14}C. Waters, J. R.; Petroff, C.; Koski, W. S. (Johnston Labs., Inc., Baltimore, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 398-404(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A bubble chamber has been operated as a counter with the propane filling being highly superheated so that it is sensitive to the low energy (average 6 keV) electrons emitted in tritrium beta decay. Experimental techniques are described using quartz chambers of 10 ml volume operated at 55°C. Three plateaus are observed in a plot of the chamber counting rate against the superheat pressure (superheat pressure equals vapor pressure at 55°C minus expansion pressure). These were due to alpha particles (30 to 40 psi) recoil protons (50 to 90 psi) and electrons (140 to 220 psi). The chamber background counting rate was stable and reproducible for long periods of time. The counting rate was shown to be proportional to the activity in a tritiated propane filling; the detection efficiency was 65% on a plateau from 200 to 220 psi superheat. Cosmic rays could be eliminated from the background counting rate using anticoincidence techniques. The background rate for a 10 ml quartz chamber shielded by 2″ of borated paraffin and 8″ of iron was 4.5 cpm. It is concluded that bubble chambers of somewhat larger size are suitable for the measurement of very low specific activities of such isotopes as carbon-14 and tritium with a sensitivity comparable to the best available gas counting systems. (auth)

9344 LOW LEVEL ENVIRONMENTAL RADIATION MONITOR WITH HIGH SENSITIVITY, STABILITY, AND DYNAMIC RANGE. Cassada Thomas E. (Southwestern Radiological Health Lab., Las Vegas, Nev.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 405-10(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

An environmental radiation monitor using a proportional counter is described which records gamma radiation levels with a logarithmic response over a dynamic range of four decades (.01 mR/hr to 100 mR/hr achievable without range switching). Constant temperature accuracy is greater than ±10% of indicated reading throughout 3.5 decades of the four decade range. A high degree of temperature stability is achieved (error due to temperature change is less than ±20% of reading over an ambient temperature range of −10°C to +55°C). Solid-state electronic circuitry is utilized exclusively for increased reliability and long term stability. (auth)

9345 PORTABLE GAMMA-RAY SURVEY METER USING SILICON AMPLIFYING RADIATION DETECTORS. Jones, A. R. (Chalk River Nuclear Labs., Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 425-31(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The survey meter measures γ-ray dose rates from background up to 20 rad/hour. The γ-ray energy range is from 30 keV to 1.25 MeV. Amplifying detectors which avalanche between 500 and 2000 volts are acceptable. The circuits, mechanical design, and performance of the silicon survey meter are described. (auth)

9346 POSSIBILITIES OF ALPHA AND BETA RAYS SELECTION MEASUREMENTS BY MEANS OF ONE DETECTOR AND ITS APPLICATION FOR MONITORING THE AREA CONTAMINATION. Novakova, Olga; Lomberska, Ljuba; Nejedly, Vladimir. Radioisotopy; 11: No. 4, 505-17(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

Possibilities of selectional and simultaneous measurements of two types of radiation (α and β) by means of a single probe are discussed. A combined detector containing a thin plastic foil for β rays and a deposited coating of ZnS(Ag) for α radiation was chosen for this purpose. Experimental results and a comparison of the pulse height and pulse shape discrimination during the measurements of α and β rays achieved through the scintillation technique are shown. Some parameters influencing the selectivity of detection are being analyzed. (auth)

9347 FUNDAMENTAL CHARACTERISTICS OF A RADIATION ELEMENT. Kovar, M. Radioisotopy; 11: No. 4, 659-72 (1970). (In Slovak).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The fundamental equations for ionization chambers are given, and the sensitivity is studied as a function of filling gas pressure and radiation energy. A sensitivity of 0.5 v/rad was achieved with a cylindrical ionization chamber of 100 mm length and 12 mm diameter. (auth)

9348 ELECTROMETRIC AMPLIFIER WITH AUTOMATIC DRIFT COMPENSATION FOR LONG-TERM OPERATION. Hekrdle, J. Radioisotopy; 11: No. 4, 679-91(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The construction of an apparatus for the measurement of small direct currents in ionization chambers for continuous gamma radiation intensity measurements in nuclear reactor halls and in similar working sites with radioactive materials, for continuous exhalation control, etc., is described. The new construction makes use of interrupted zero setting with the use of serial negative feedback. A simple relay is used on the input of the amplifier, performing in intervals of two seconds the drift compensation of the whole amplifier. During this zero setting period the measuring range may be automatically switched over without any danger of overloading. The amplifier is completely fitted with silicon transistors. (auth)

9349 COUNTING RATE IN DETECTING CYLINDRICAL HOMOGENOUS γ SOURCES. Munteanu, G. Bul. Inst. Politeh. Brasov, Ser. B, 12: 327-30(1970). (In French).

In the detection of a cylindrical homogeneous γ source contained in a tube using a counter placed on the exterior wall of the tube, the relation of the counting rate to the length of the pipe was studied considering both the self-absorption and the multiple scattering of the γ rays. Comparison of the theoretical results with experimental results showed agreement on the saturation character of the counting. From the experimental results a simplified expression is obtained for the counting rate as a function of the length of the tube. (J.S.R.)

9350 HIGH PRECISION CHARGED PARTICLE DETECTOR USING NOBLE LIQUIDS. Derenzo, S. E. (Univ. of California, Berkeley). Nature (London); 233: No. 5322, 617(29 Oct 1971).

Work on the development of a thin multiconductor chamber filled with liquid xenon to form a proportional counter is briefly described. In the thin form such an instrument shows high precision in the avalanche model, and in the thick form it also provides efficient and rapid x-ray and γ-ray detection. The thin form should prove very valuable in high energy and cosmic ray physics, and the thick form in radiology. (UK)

9351 INSTA-GEL SCINTILLANT FOR ^{45}Ca COUNTING IN BIOLOGICAL SAMPLES. Blanusa, M.; Kastelan, M. (Inst. for Medical Research, Zagreb). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 723-8(Dec 1971).

The liquid scintillation counting of ^{45}Ca in biological material with a new scintillant, Insta-Gel, was tested. Aqueous acid solutions of carcass, urine and faecal ash containing ^{45}Ca and up to 50 mg of stable calcium were mixed with Insta-Gel with little or no quenching effect. Nontreated human and rats' serum was also mixed with Insta-Gel and the ^{45}Ca estimated. Counting efficiencies of up to 80% were obtained. The advantages of the method are discussed. (auth)

9352 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR DETECTING RADIATION. Cairns, James Anthony; Desborough, Colin Leonard (to United Kingdom Atomic Energy Authority). British Patent 1,256,396. 8 Dec 1971. Filed 30 May 1969.

Reference is made to apparatus primarily for the detection of x-radiation. The apparatus described comprises a hollow electrode having a window for transmitting radiation at one end, and containing a second electrode of elongated form adjacent to the window. The conducting support means for this second electrode is supported by the first electrode. The window is preferably plane, with the second electrode extending parallel with its plane. The hollow electrode is preferably made the cathode, and the second electrode the anode, and the window is electrically conducting and forms part of the cathode. A cover is provided and arranged in such a way that the second electrode may be replaced without loss of vacuum. The support means for the second electrode may comprise a shield at cathode potential. Means are provided for adjusting the separation of the second electrode from the window. A detailed description, including mode of operation, is given. (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 9256, 9298, 9394, 10890, 10901, 10903, and 10904.

9353 (BARC-551) CONSTANT ACCELERATION MOESSBAUER SPECTROMETER. Mathews, C. K. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 10p. Dep. NTIS (U. S. Sales Only).

A constant acceleration Moessbauer spectrometer is described. It consists of an electromechanical transducer, an electronic control unit to drive the transducer, a counting system and a multichannel analyzer operating in the time mode. The line width and the linearity of the velocity scale are shown to be quite satisfactory. A dipstick type cryostat is used in low temperature measurements. (auth)

9354 (UCRL-73247) HIGH STABILITY PULSER AND CHARGE INJECTION CAPACITOR FOR SERVOSTABILIZATION OF HIGH RESOLUTION GAMMA RAY SPECTROMETERS. Bradley, Arne E. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Oct 1971. 24p. (CONF-711111-15). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The design of a reference pulser and air-dielectric capacitor for use in stabilization of high-resolution Ge(Li) gamma-ray spectrometers is discussed. Additionally, the adverse effects of coaxial cable series resistance and detector coupling capacitor instability are considered. The reference pulser circuitry is completely transistorized and features a highly-stable dual-transistor pulse generation network. The temperature stability of the pulser output is $\leq \pm 5$ ppM/°C from 10°C to 50°C. The long-term stability is approximately $\pm .02$ channels per day. The air-dielectric capacitor is a three-terminal device constructed of Kovar-steel and glass. The rigid glass-metal seal insures long-term stability. The capacitance temperature coefficient from liquid nitrogen to room temperature is approximately +10 ppM/°C. Data are presented which shows that the series resistance of a coaxial cable will cause significant pulse drift when terminated and essentially no drift if left unterminated. An analysis also indicates that drift in a detector coupling capacitor can produce uncorrectable spectral drift. (auth)

9355 (UCRL-73521) EXPERIENCE IN THE USE OF AN ANTICOINCIDENCE SHIELDED Ge(Li) GAMMA-RAY SPECTROMETER FOR LOW LEVEL ENVIRONMENTAL RADIONUCLIDE ANALYSIS. Phelps, P. L.; Hamby, K. O. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Oct 1971. 28p. (CONF-711111-18). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

An evaluation of a low level, high resolution anticoincidence shielded Ge(Li) spectrometer, constructed over five years ago, has been made. The evaluation was based upon results obtained in assaying a variety of biological and environmental samples, each contained in a 200 cm^3 aluminum can. The spectrometer used an 18 cm^3 planar type Ge(Li) detector. An example of the very high sensitivity possible with the spectrometer was in the assaying for ^{137}Cs in a 296 gram soil sample which was determined to have a concentration of 0.027 pCi of ^{137}Cs per gram of soil. Description of the spectrometer, methods used in data analysis and results of counting low level samples are given. (auth)

9356 (UCRL-73561) PORTABLE Ge(Li) DETECTOR FOR FIELD MEASUREMENT OF RADIONUCLIDES IN THE ENVIRONMENT. Phelps, P. L.; Anspaugh, L. R.; Koranda, J. J.; Huckabay, G. W. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Nov 1971. 24p. (CONF-711111-25). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A description of a portable Ge(Li) field spectrometer and its application to in situ measurements is given. The mathematical techniques of calibrating the spectrometer so that field spectrometer counting rates may be converted into units of soil activity are

developed. The quantification of gamma-ray emitting radionuclides in the field has proven to be more sensitive than laboratory analysis using Ge(Li) anticoincidence shielded spectrometers. This was demonstrated by obtaining approximately the equivalent statistical accuracies for quantifying several radionuclides from a 30 min field count as compared to a 1437 min laboratory analysis. A comparison between the results obtained from field analysis with those obtained by returning the samples to the laboratory are given for natural radionuclides and ^{137}Cs. An example of qualitative spectral data obtained from field measurements of gaseous emissions from a BWR reactor is also given. (auth)

9357 GAMMA RAY SPECTROMETER. Grenier, Gerard (to Commissariat a l'Energie Atomique). French Patent 2,055,792. 30 Apr 1971. Filed 19 Aug 1969. (In French).

A γ-ray spectrometer operating over a wide energy band, but principally intended for low energies, is described. It includes two Li-compensated Ge detectors in a cryostat, one of the detectors being very thin. A scintillator surrounds the assembly and is associated with at least one photomultiplier. The spectrometer is provided with means for analyzing the electrical pulses produced by the detectors and the photomultiplier. (France)

9358 X SPECTROMETRY WITH Si(Li) DETECTORS. Friant, A.; Gras, R.; Lorin, A.; Saliou, C. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Instrum. Nucl.; No. 42, 34-41(Jan 1971). (In French).

Improvements were made to Si(Li) detectors rendering them suitable for use in x-ray spectrometry between 1 keV and a few tens of keV and soft γ-ray spectrometry. Their performances are given. (France)

9359 BEHAVIOR OF HIGH-PURITY GERMANIUM NUCLEAR COUNTERS AT LOW TEMPERATURE. Stuck, R. (Centre de Recherches Nucleaires, Strasbourg); Ponpon, J. P.; Siffert, P.; Ricaud, C. Appl. Phys. Lett.; 19: No. 11, 461-3(1 Dec 1971).

Gamma-ray spectrometers prepared from high-purity germanium have been operated at low temperatures down to 5°K. The energy resolution of completely depleted detectors was the same at 5°K as at 77°K and no trapping-detrapping phenomena were observed. However, at sufficiently low bias voltage, slow components appeared on the pulses below 8°K. This effect is shown to be related to the increase in the resistivity of the undepleted region. (auth)

9360 PROCEDURE FOR MEASURING THE QUANTITY OF Pu CONTAINED IN WASTE MATERIALS. Baron, Henri; Boisard, Pierre; Bourliaud, Jean; Lerochereuil, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,061,926. 1 Jun 1971. Filed 2 Oct 1969. (In French).

A procedure for measuring the quantity of Pu contained in radioactive wastes is described. A vessel containing the waste matter is displaced in a spiral motion in front of a detecting device in such a way as to present the entire height of the vessel along the displacement axis, at the same time turning the vessel through 180° about this axis. When the vessel comes to the end of this motion, the movement is reversed until its original position is regained. The signals supplied by the detecting device are amplitude discriminated in order to isolate the signals corresponding to the 384 keV γ peak. (France)

9361 SIMPLE METHOD FOR ANALYSIS OF GAMMA-RAY SPECTRA MEASURED WITH Ge(Li) DETECTORS. Mizohata, Akira; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 29-35(1970).

A computer method is described that makes it possible to automatically analyze γ-ray spectra measured with a Ge(Li) detector. The method includes a simple procedure for peak finding by analyzing the second difference function. The program reads the entire spectrum, finds out peaks and determines their amplitudes, centroids and widths by least squares fitting. The chosen mathematical models for peak and background are a Gaussian function and a cubic function, respectively. A determined data interval is handled on the assumption that it includes less than four peaks. (auth)

9362 CHARACTERISTICS OF AN ULTRA-HIGH RESOLUTION Ge(Li) SPECTROMETER FOR SINGLES AND COINCIDENCE X-RAY AND GAMMA-RAY STUDIES. Palms, J. M.; Rao, P. Venugopala; Wood, R. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 36-46(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The use of an ultra-high resolution Ge(Li) photon spectrometer in low and high energy x-ray and gamma-ray measurements has been evaluated. Studies were made of the resolution, low energy cutoff, the full energy and K X-ray escape efficiencies, the effective detector dead layer and the detector linearity. The detector was used simultaneously with a high resolution Si(Li) detector to measure fast coincidences between K_{α_1}, K_{α_2} and L X-rays, as well as coincidences between K, L conversion electrons and L X-rays. A detailed discussion is presented of the electronic problems associated with making these kind of measurements. Measurements were also made of X-ray beams produced by clinical X-ray machines at 40, 78 and 220 kV. (auth)

9363 WELL-TYPE Ge(Li) DETECTOR. Santhanam, S. (Loyola Coll., Montreal); Webb, P. P.; Monaro, S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 75-81 (Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The feasibility and usefulness of a coaxial Ge(Li) spectrometer as a well-type detector for sum spectra of coincident gamma rays is demonstrated. A 16 cm^3 hollow cylindrical germanium detector has been made and mounted in such a way that access to the center of the detector is achieved from outside the cryostat. The detector is a fully depleted structure in which a hole of 1 cm diameter was ultrasonically cut, and a non-injecting contact applied to the inside surface. The measured resolution of the detector for a 1173 keV gamma ray sum peak from ^{144}Pm was 2.6 keV f.w.h.m., which was mainly limited by statistics and preamplifier noise. The detection of sum lines arising from 2 or more coincident gamma rays is demonstrated by using the radioactive source of ^{144}Pm. With the source inside the well, for which the counting solid angle is nearly 4π, the sum peak of three lines at 1791 keV (696 + 618 + 477) was observed with an energy resolution of 3.5 keV f.w.h.m., and a peak to background ratio greater than 15:1. For the source outside the detector at a distance of 10 cm, this sum line was not observed above background for comparable counting statistics. Comparison is also made to results obtained from a 3'' well-type NaI(Tl) crystal. Although the efficiency of the Ge(Li) spectrometer is not as high as that of the NaI(Tl), it is shown that this limitation is more than offset by its superior resolution. (auth)

9364 ONBOARD CALIBRATION SYSTEM FOR γ-RAY SPECTROMETERS IN SPACE SATELLITES. Chupp, E. L.; Lavakare, P. J.; Sarkady, A. A. (Univ. of New Hampshire, Durham). IEEE (Inst. Elec. Electron, Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 309-13(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The fabrication method and test results for ^{60}Co and ^{241}Am calibration sources to be used in an onboard calibration system for a γ-ray spectrometer and associated x-ray detector to be flown on an earth orbiting satellite are described. The system consists of radioactive sources loaded into scintillator buttons which register the charged decay particles (betas and alphas) emitted by the radionuclides in coincidence with γ-rays. The latter are detected by γ-ray and x-ray spectrometers as calibration lines. The scintillator button is viewed by a separate photomultiplier tube so the light pulses resulting from the charged decay particles can be used to gate off the calibration γ-ray lines from the spectrometers during the normal mode of operation. The calibration is achieved by accepting only those pulses which are in coincidence with the pulses from the scintillator button, thus recording the calibration lines from the radioactive source. Some suggestions for future developments are also briefly discussed. (auth)

9365 ELECTRONICS SYSTEM FOR GAMMA-RAY SPECTROMETRY IN SATELLITE APPLICATIONS. Harrington, Timothy M.; Marshall, J. Howard III. (Analog Tech. Corp., Pasadena, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 314-21(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The design techniques and performance of a prototype electronics subsystem for a γ-ray spectrometer intended for spaceflight applications are described. The spectrometer uses a NaI(Tl) crystal for γ rays between 100 keV and 8 MeV and a proportional counter for X rays between 1 and 10 keV. The 512-channel analog-to-digital converter is based on a design for Ge(Li) detectors and interfaces with a logic system providing serial readout of completely formatted spectral data. The instrument contains high-voltage power supplies for detector biasing and operates from 1.2 W of +28 ±5 Vdc. Measurements show an electronic gain stability of ±0.09% for temperatures from −50°C to +75°C and a differential linearity no worse than ±0.2% for the top 99% of the channels. Spectra from ^{22}Na and ^{55}Fe are presented. (auth)

9366 PRIMARY ELECTRON DETECTOR EXPERIMENT FOR OGO-E. Rogowski, L. K.; Hicks, D. B.; Gilland, J. R.; Swanenburg, B. N. (Ball Brothers Research Corp., Boulder, Colo.).

IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 352-8(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A primary electron detector has been designed to measure the electron component in the primary cosmic radiation. The measurement will reveal the absolute flux and energy spectrum of electrons in the energy range of 0.5 to 10 GeV. The experiment will also measure gamma rays above 500 MeV and protons between 20 and 100 GeV. The detector system consists of five individual radiation counters that are further grouped into the following subsystems; a lead glass total absorption spectrometer crystal, a cesium iodide-glass scintillator phoswich, and a cesium iodide-plastic scintillator phoswich. All detectors are viewed by RCA 7151-N multiplier phototubes. The outputs of the photomultipliers are fed directly into the electronics where they are properly separated, amplified, and where the necessary coincidence/anticoincidence logic requirements are met. Of special interest in the electronics systems are the logarithmic amplifiers and pulse splitting circuits used on the phoswich signals. A three-decade logarithmic amplifier was also used for the lead glass subsystem. Several configurations were studied before a final decision was made to use a straight-line approximation system. The experiment was launched on an Orbiting Geophysical Observatory (OGO-E) in early 1968. The final configuration has an envelope volume of about 950 cubic inches, weighs 16 pounds, and operates on 1.1 watt of power. (auth)

9367 DESIGN OF A LINEAR GATING MULTIPLEXER AND ITS USE IN NUCLEAR PULSE SPECTROSCOPY. Gere, E. A.; Lie, H. P. (Bell Telphone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 436-9(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The design of an inexpensive linear gating multiplexer with unambiguous pulse labelling is discussed. In the linear gates, a technique of switching gain elements inside the overall feedback loop results in good pulse height stability and strong rejection of unwanted pulses. The use of the multiplexer in some typical situations is discussed, and some possible pitfalls arising from the configuration of associated apparatus are pointed out. (auth)

9368 CHARGE-SENSITIVE PREAMPLIFIER USING OPTOELECTRONIC FEEDBACK. Goulding, Frederick S.: Hansen, William L.: Walton, John T. (to United States Atomic Energy Commission). U. S. Patent 3,611,173. 5 Oct 1971. Filed 3 Nov 1969.

A low-noise integrating preamplifier, particularly useful for the processing of signals in semiconductor-detector nuclear radiation spectrometers to provide a significant improvement in the energy resolution, is described. Noise reduction and increased resolution are achieved by employment of optoelectronic feedback to simulate a pure resistance, in place of the component resistor conventionally employed as the DC feedback element of a conventional preamplifier. (auth)

9369 LARGE VOLUME PLANAR PAIR GERMANIUM (LITHIUM) DETECTOR. Baum, John J.: Helenberg, Harold W. (to United States Atomic Energy Commission). U. S. Patent 3,612,869. 12 Oct 1971. Filed 27 Feb 1970.

An assembly of lithium-drifted germanium detectors of the planar type combines the good detection characteristics of the planar detector with the large volume of the coaxial drift geometry. The detector assembly is constructed by placing two lithium-drifted germanium detector diodes back to back and connecting them electrically in parallel. The detector is held in a mounting structure that maintains each of the diodes at the same temperature. (auth)

9370 MOESSBAUER SPECTROMETER. Ord, Richard Neil (to United States Atomic Energy Commission). U. S. Patent 3,612,875. 12 Oct 1971. Filed 15 Oct 1970.

A Moessbauer spectrometer includes a source shielded by a layer of depleted uranium covered with a layer of graded shielding material. A detector is placed so that it is shielded from the gamma radiation from the source. The sample being examined is inclined at an angle to the beam of gamma rays from the source so that the resonant and nonresonant gamma-ray energy is directed to the detector. (auth)

High Energy Physics Instrumentation

9371 (ITEF–837) LUMINOSITY OF THE 1.5-METER TRACK SPECTROMETER. Aref'ev, A. V.; Bayukov, Yu. D.; Efremenko, V. I.; Zaitsev, Yu. M.; Kozodaev, M. S.; Leksin, G. A.; Molotkov, G. P.; Suchkov, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The description of a spectrometer consisting of a 150 × 60 × 40 cm^3 spark chamber in a 15.7 kG magnetic field and multichannel system of scintillation counters is given. The design and spatial and momentum resolutions are discussed in detail. (auth)

9372 (ITEF–843) CALCULATION OF THE CHARACTERISTICS OF A MAGNETIC MISSING-MASS SPECTROMETER. Blagorodov, A. M.; Borodina, I. N.; Luzin, V. N.; Radkevich, I. A.; Sokolovskii, V. V.; Tomashuk, Yu. F.; Yushchenko, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

The methods for calculation of characteristics and the characteristics of a magnetic missing mass spectrometer are described. These include the efficiency of the spectrometer, the boundaries of the phase volume for the variables, and the reaction angle-recoil particle momentum. Also, the contribution from the nonresonant background is calculated for the interaction $\pi^- p \rightarrow px^-$. The calculated results are compared with the experimental data. (auth)

9373 (LUIP-CR-71-7) USE OF ILFORD K2 NUCLEAR EMULSIONS IN STUDIES OF THE COSMIC RAY CHARGE SPECTRUM. Rosander, R. (Lund Univ. (Sweden). Dept. of Physics). Nov 1971. 25p. Dep. NTIS (U. S. Sales Only).

Photometric mean track width measurements were carried out on about 200 primary cosmic ray particles ($5 \leq Z \leq 26$), stopping in an Ilford K2 emulsion stack. The standard deviation of the experimentally determined charge values is about 0.3 units of charge in the whole spectrum, when the residual range interval 0.5 to 10.5 mm has been used for identification. The resolution compares as well with the charge resolution obtained with other types of cosmic ray detectors. (auth) Sweden)

9374 FILM-TRANSPORT SYSTEM OF SCANNING AND MEASURING TABLE FOR EVALUATION OF BUBBLE-CHAMBER FRAMES. Novak, J.; Sandtner, J.; Jehlicka, B. (Inst. of Physics, Prague). Czech. J. Phys.; 21: No. 10, 1046-50(1971).

A simple three-channel film transport system of a scanning and measuring table is described. Automatic frame stopping is provided by means of an analogue signal derived from the shape of the Brenner mark. The rate of film travel in the three channels during high-speed rewinding is regulated to equal values in order to maintain the correlation of corresponding frames. The films move on air cushions over the frame gates and after stopping they are press-suction fixed. (auth)

9375 CYLINDRICAL COSMIC-RAY TELESCOPE CHARACTERISTICS. Kavlakov, S. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 229-40(1971).

For proper interpretation of the data from continuous cosmic-ray intensity measurements it is necessary to know the exact geometrical characteristics of the measuring apparatus. Cylindrical telescopes, usually consisting of plastic scintillators, have recently been developed. Methods for calculation of radiation sensitivity and lightpower of cylindrical telescopes with different arrangements of detecting surfaces are analyzed. The fundamental formulas are given, and the sensitivities for some of the most-used telescopes are calculated and plotted. (R.W.R.)

9376 PROPERTIES OF NUCLEAR EMULSIONS WITH SMALL SHRINKING COEFFICIENT. Geshkov, I. M.; Lonina, N. A.; Todorov, P. T.; Chernev, Kh. M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 125-31(1971). (In Russian).

Four-times diluted nuclear emulsion plates, type N1KFI-BR-1, perpendicularly exposed to deuterons, were soaked with a plasticizer for decreasing their shrinking coefficient. Three recording plates, with shrinking coefficients of 2, 0.5, and 0.25, were investigated under equal conditions of exposure. On statistics of 145,762 recorded tracks the following were studied: the availability of stationarity in the swollen plate, the precision of measuring the ranges, preserving the number of tracks, the efficiency of their recording, and the speed of scanning. With the decrease of the shrinking coefficient, the precision of measuring the ranges essentially increases. It is shown that, even at the biggest swelling (coefficient of shrinking 0.25), within one standard deviation, loss of tracks in the investigated ranges is not noticed. Their structural variations, however, have an effect in a certain decrease of the efficiency and rate of scanning. (auth)

9377 MULTILAYER SHOWER TOTAL ABSORPTION SPECTROMETER FOR MEASURING ENERGY OF HIGH-ENERGY ELECTRONS AND PHOTONS. Grishaev, I. A.; Krinitsyn, A. N.; Lapin, N. I.; Pugachev, G. D.; Shramenko, B. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 866-7(May 1971). (In Russian).

The subject shower photometer is characterized by full absorption and is intended for studying the energy spectra of photons, or of 2-GeV electrons from a linear accelerator. The radiator consists of a bank of 14 lead plates, alternately arranged with 14 scintillator plates, with a total length of 210 mm and a cross section of 150 × 150 mm. The spectrometer is calibrated with monoenergetic electrons from a linear accelerator. Resolution at high energies suggests that this spectrometer may be useful in the 1,100 MeV region for electrons and photons. (K.S.W.)

9378 ON-LINE ANALYSIS OF WIRE SPARK CHAMBER DATA. Beniston, M. J. (IBM Scientific Center, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 114-21 (Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968.

By attaching a medium-sized computer (IBM 1800) on-line to a wire spark chamber system and using simple algorithms, it is possible to analyze all the events and thus have much improved capability of monitoring the experiment. The information so obtained and how it can be used are described. (auth)

9379 COMPUTER ANALYSIS OF TRACKS IN NUCLEAR EMULSION UTILIZING DIGITIZED VIDEO SCAN. Ehrmann, C. H.; Reames, D. V. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 127-31(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A system has developed to make density measurements on particle tracks in nuclear emulsions. The output signal of a videcon viewing the track through a microscope is digitized to detect developed grains in the emulsion. This digitized information is transferred in real time to a computer which selects grains falling in the track and sums their volumes and computes parameters related to their spatial distribution. Analysis of tracks at arbitrary angles is accomplished by rotating the track image in the focal plane with a Pechan prism and by driving the focal plane through the emulsion while taking data. (auth)

9380 GAMMA RAY TELESCOPE UTILIZING LARGE AREA WIRE SPARK CHAMBERS. Ross, R. W.; Ehrmann, C. H.; Fichtel, C. E.; Kniffen, D. A.; Oegelman, H. B. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 304-8(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A second generation gamma-ray telescope has been developed for further experiments in balloon-borne astronomy. This instrument is composed of 32 wire-grid spark chamber modules, each 50×50 cm^2, utilizing two-coordinate ferrite core readout. The detector is flown on a 27 million cubic foot research balloon in a search for discrete gamma-ray sources and supernovae explosions. (auth)

9381 SATELLITE SOLAR COSMIC RAY SPECTROMETER WITH ON-BOARD PARTICLE IDENTIFICATION. Lanzerotti, L. J.; Lie, H. P.; Miller, G. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 343-51(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The design and calibration results of a satellite based solar-cosmic ray particle identifier system utilizing a field effect transistor analog multiplier for the IMP F and G spacecraft are described. A discussion is made of the effectiveness of particle separation by such a particle identifier used in on-board data processing. (auth)

Radiation Dosimeters

Refer also to abstracts 8894, 9308, 9320, 9521, and 9551.

9382 (UCLA-12-851) SOIL THERMOLUMINESCENCE IN RELATION TO RADIATION EXPOSURE UNDER FIELD CONDITIONS. Nishita, H.; Hamilton, M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1971]. Contract AT-04-1-GEN-12. 28p. Dep. NTIS.

Experiments were conducted to determine the relationship of soil thermoluminescence to ionizing radiation exposure under the conditions of natural environment using the ^{137}Cs radiation field at the Nevada Test Site. In experiment I, soil columns were buried in the ground and irradiated at a fixed distance from the ^{137}Cs source. In experiment II, they were exposed on the ground surface at 12 different distances from the source. Soil thermoluminescence was determined in three ways, i.e., glow curve area below 200°C, glow curve height at 200°C, and total area. Both experiments showed that soil thermoluminescence is highly correlated with radiation exposure level. The first two methods of measuring thermoluminescence gave correlation coefficients $r > 0.915$. The "total area" method gave high correlation coefficient $r > 0.951$ for the noncalcareous soil, but low coefficient $r < 0.769$ with the highly calcareous soil studied, indicating that this method cannot be applied to the latter soil type. Under the experimental conditions that prevailed, the minimum radiation exposure level required to produce measurable soil thermoluminescence appeared to be in the 20 to 85 R range. (auth)

9383 (UCRL-Trans-10561) THERMOLUMINESCENT PROPERTIES OF OPTICAL-GRADE LiF. Lee, Ge Chul; Lee, Sang Soo. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from J. Nucl. Sci. (Seoul); 10: 1-6(1970). 9p. Dep. NTIS.

A comparison is made between the glow curves of optical grade single crystal LiF and of LiF activated by impurities. Because the LiF used is not activated by impurities, the level of TL is low and shapes of the glow curves are different. Thus the effects of the activated impurities can be easily seen. In addition, the annealing effect of the experimental materials is examined, but the dependency of this effect in annealing time and temperature does not exceed more than ±5%. The influence of the rate of temperature increase of the electric furnace is discussed, and the experimental apparatus is described. (auth)

9384 HIGH LEVEL DOSIMETRY BY OPTICAL ROTATION. Venkataramani, R. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 11: No. 1, 15-17(Oct 1971).

The present investigation deals with the study of change in angle of specific rotation under irradiation of aqueous solutions of sucrose, glucose, fructose and arabinose with a view to explore their usefulness for dosimetry in the Mega rad range. The study was carried out by irradiation of air-equilibrated as well as nitrogen-equilibrated aqueous solutions and also in the presence of thiourea. Of the systems studied air-equilibrated aqueous arabinose solution gave a smooth response of the angle of specific rotation with dose. The change in angle of specific rotation with dose was independent of dose rate and a dose ranging from 1 to 100 M rad could be measured conveniently with 4% error. Radiation degradation of arabinose in aqueous solution seemed to follow the reaction of the first order. (auth) (UK)

9385 ENVIRONMENTAL RADIATION MONITORING WITH THERMOLUMINESCENT DOSIMETERS. Hoy, J. E. (E. I. du Pont de Memours and Co., Aiken, S. C.). Health Phys.; 21: No. 6, 860-2(Dec 1971).

The monitoring of the environment around the Savannah River Plant with a three-detector unit of thermoluminescent dosimeter ribbons is briefly described. The unit consisted of one CaF : Dy and two LiF : Mn ribbons. The CaF : Dy ribbon was limited with a silver shield to photon energies greater than 100 keV. If, during a 28-day exposure, the CaF : Dy ribbon detected an abnormally high background, the LiF : Mn ribbons were used to verify and interpret exposures. Readings, calibration, and advantages over a single-crystal system are discussed. (UK)

9386 PORTABLE LOW-ENERGY PHOTON CALIBRATION SOURCE. Boggs, J. V. (Univ. of California, Livermore). Health Phys.; 21: No. 5, 631-5(Nov 1971).

A small portable source holder was built to provide monoenergetic low-energy photon irradiation fields. The source holder used 7 Ci of ^{241}Am as the primary source, which provides 59.6-keV γ rays, and various targets as lower energy secondary sources, providing fluorescent x-rays. These secondary x-rays range in energy from 4.5 keV (titanium) to 51 keV (thulium) and yield exposure rates of a few hundred mR/hr at 8 cm from the target. The exposure rate 10 cm from the primary source is 7.6 R/hr. Neutrons are emitted as well since the source material is in an oxide form. This could result in calibration problems at irradiation positions very close to the holder. (auth)

9387 CALORIMETRIC MEASUREMENT OF ^{60}Co GAMMA SOURCES. Ohnishi, Tokuhiro; Furuta, Junichiro; Hiraoka, Eiichi; Okamoto, Shinichi. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 118-20(1970).

The source intensity was measured by the calorimetric method, absorbing the γ-rays from ^{60}Co in water and Pb. The results are almost the same as those from the Radocon dose meter of Victoreen Co. Ltd. It is concluded that this calorimetric method can be used effectively to measure the absolute values of curies of ^{60}Co. (auth)

9388 RADIATION DOSIMETRY WITH DITHIZONE SOLUTIONS IN DIFFERENT ORGANIC SOLVENTS. Dejehet, F. G.; Apers, D. J.; Capron, P. C. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). Bull. Soc. Chim. Belg.; 80: No. 7-8, 481-500(1971). (In French).

The G-value for dithizone transformation in several organic solvants under γ radiation has been determined. In chloroform, at concentrations of 10^{-3}, 2.10^{-5}, and 10^{-4} mol l^{-1} the following values were measured respectively: 13.3 ± 0.6; 13.6 ± 0.5, and 15.4 ± 2.1. In dichloromethane, at 2.10^{-5} mol l^{-1}, $G(-_{dith.}) = 11.5 \pm 0.9$ which is decreased to 9.4 ± 0.6 when 1% ethanol is added. At a concentration of 3.10^{-5} mol l^{-1} in cyclohexane, a value of 5.9 is obtained. These values have been obtained in the presence of oxygen. It may be concluded that the dithizone-chloroform solution at 2.10^{-5} mol l^{-1} can be used as a suitable dosimeter between 25 and 600 rads. In this range it shows a linear dose response. (auth)

9389 HIGH-SENSITIVITY STIMULATED EXOELECTRON EMISSION RADIATION DOSIMETERS. Becker, Klaus H.; Cheka, Joseph S.; Gammage, Richard B.; Robinson, Eddie M. (to United States Atomic Energy Commission). U. S. Patent 3,612,868. 12 Oct 1971. Filed 26 Jun 1970.

An inert metal, such as palladium, platinum, or gold, in low concentration, impregnated or diffused to a sufficient depth in materials that exhibit the physical effect of stimulated exoelectron emission (SEE), substantially increases the radiation sensitivity of the SEE materials by permitting a larger percentage of exoelectrons to be emitted. The reproducibility of response is also increased. Impregnation or diffusion in such materials can be accomplished, for example, by thermal diffusion of metal layers into the surface or throughout the bulk material. The exact procedure for obtaining optimized sensitivity depends upon which inert metal is utilized with a given SEE material, the thickness of the metal, and the diffusion conditions. (auth)

9390 DOSIMETER FORMED OF A RADIATION SENSITIVE THERMOLUMINESCENT MATERIAL AND METHOD OF READING THE SAME. Kastner, Jacob; Oltman, Billie G. (to United States Atomic Energy Commission). U. S. Patent 3,610,926. 5 Oct 1971. Filed 9 Sep 1969.

A dosimeter that incorporates a crystalline thermoluminescent structure to store radiant energy is described. The crystalline thermoluminescent material can be a combination of different materials or a single material. The dosimeter is read out by applying energy to the crystal to cause mechanical vibration or crystal lattice vibration at the natural resonant frequency of the crystal. The energy applied may be an alternating current or coherent light energy as desired. (auth)

9391 IMPROVEMENTS IN OR RELATING TO RADIATION DOSIMETER DEVICES. Swain, Ann; Sheldon, Robert; Stapleton, Geoffrey Brian (to Science Research Council). British Patent 1,252,591. 10 Nov 1971. Filed 12 Feb 1968.

The dosimeter described comprises a glass or like material gastight envelope containing a material that evolves a gas under irradiation, and an electrode system connected to an external circuit adapted to indicate the quantity of evolved gas and hence the dose of ionizing radiation. For measuring high energy radiation (γ or proton), polyethylene powder or film is suitable, evolving H_2. The electrode system may include a thermionic filament and a collector electrode, adapted to operate like an ionization gauge; this is a particularly suitable arrangement for low dose rates. Alternatively, two plane electrodes may be provided to constitute a spark gap, and the gas pressure is determined by measuring the potential required across the electrodes to break down the gap; this arrangement is more suitable for higher dose rates. (UK)

9392 IMPROVEMENTS IN OR RELATING TO RADIATION DOSIMETER DEVICES. Swain, Ann; Sheldon, Robert; Stapleton, Geoffrey Brian (to Science Research Countil). British Patent 1,252,592. 10 Nov 1971. Filed 12 Feb 1968.

Reference is made to dosimeters of the type employing a material that evolves gas under irradiation, the quantity of evolved gas being proportional to the radiation dose. In one arrangement described, a sealed glass or silica capsule, preferably having a frangible teat, is employed. The capsule, after irradiation, is placed within a constant volume apparatus connected to a pressure gauge. The teat is then broken to release the gas into the apparatus. The quantity of evolved gas, and hence the integrated radiation dose, can be derived from the indicated pressure. In another arrangement an Al capsule is employed, sealed by cold welding, and a method is described for forming such a capsule. The gas is released by puncturing the capsule. For measuring high energy radiation (γ- or proton) the gas evolving material is conveniently polyethylene powder, film, or in disk form, in which case the evolved gas is hydrogen. (UK)

9393 SOLID OXALIC ACID AS A CHEMICAL DOSIMETER FOR MIXED PILE RADIATION IN MULTIMEGARAD RANGE (100 TO 1000 MRAD). Gal, O. S.; Draganic, I. G. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 753-7(Dec 1971).

The measurements with $H_2C_2O_4 \cdot 2H_2O$ were carried out inside the cores of the heavy water reactor RA at Vinča (Yugoslavia), the light water reactor ISIS at Saclay (France) and the light water reactor WWR-SM (Hungary). The results obtained suggest that oxalic acid dihydrate can be a simple solid chemical dosimeter, suitable for in-pile monitoring in the dose range 100 to 1000 Mrad with an accuracy of 10%. The absorbed dose is calculated from the equation $D = a \log g_0/g$, where g_0 and g are the weights of oxalic acid before and after irradiation, respectively. The proportionality constant a is specific for the radiation field and has to be calibrated by an absolute dosimeter (calorimeter). (auth) (UK)

9394 ABSOLUTE GAMMA-RAY DOSIMETRY BY RECOIL ELECTRON SPECTROSCOPY. Strash, Alfred M. (Macalester Coll., Saint Paul, Minn.); Gold, Raymond. Nature (London); 234: No. 5327, 260-2(3 Dec 1971).

A new method of absolute gamma-ray dosimetry which is based on recent work in Compton recoil gamma-ray spectroscopy and which properly accounts for the most fundamental quantity in the specification of a gamma-radiation field, namely the absolute gamma-ray energy spectrum, is described. (auth)

9395 PRESENT STATUS OF DEVELOPMENT OF GLASS THERMOLUMINESCENT DOSIMETERS IN CSSR. Suran, J.; Neruda, J. Radioisotopy; 11: No. 4, 615-25(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

A series of experimental melts was performed to find a thermoluminescent glass of suitable properties for a glass dosemeter. Some results of the dosemeter design optimization (the mass of the semiproduct, its shape, the heat-up conditions and the necessary power input) are presented. Various methods of exposure dose rate determination by means of the thermoluminescent glass are discussed and the results of essential experiments with a number of photosensitive elements are given. (auth)

9396 DEVICE FOR EVALUATION OF A THERMOLUMINESCENT DOSIMETER. Volny, J.; Vobornik, J.; Rans, J. Radioisotopy; 11: No. 4, 627-31(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

A device for evaluation of a thermoluminescent dosimeter for gamma dose exposures from 1 to 1600 R is described. The construction and the use of the dosimeter used in connection with this device are described. The problems of the readout device are discussed and a description of the method is illustrated. The operation and service instructions are given in brief. (auth)

9397 SIMULTANEOUS ESTIMATION OF EXPOSURE DOSE AND TIME ELAPSED SINCE EXPOSURE USING MULTIPEAK THERMOLUMINESCENT DOSIMETER. Spurny, Z. Radioisotopy; 11: No. 4, 633-46(1970). (In Czech).

From second national radiological symposium; Jachymov, ho-Czechoslovakia (20 Apr 1970).

The knowledge of the time of exposure may be useful in personal monitoring, for example, in time-reconstruction of over-exposures or nuclear accidents or in the choice of therapy procedures, etc. The application of multipeak thermoluminescent phosphors for simultaneous estimation of exposure and time elapsed since exposure is described. The preparation of a dosimeter, as well as its parameters and a technique for simultaneous measurement of both values are described; and an application of this principle in personal monitoring is discussed. (auth)

9398 LiF THERMOLUMINESCENCE DOSIMETRY. Novotny, J.; Hedvicakova, L.; Spurny, Z. Radioisotopy; 11: No. 4, 647-58(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The experiences with TL apparatus and LiF dosimeters are described. The reproducibility of samples preparation and dose response curve was determined and TL properties of used phosphors were compared with LiF (TLD-100) of Harshaw Chem. Co. Percentage depth dose in various water phantoms was established with LiF dosemeters. The suspension of LiF in water was used

for measuring the dose in certain volumes of liquids, and observed data were compared with data from a Fricke dosimeter. (auth)

9399 ROLE OF SILICON ACTIVATOR IN EXOELECTRON EMISSION FROM BeO. Gammage, R. B.; Crase, K. W.; Becker, K. (Oak Ridge National, Tenn.). Health Phys.; 22: No. 1, 57-63(Jan 1972).

The very high radiation sensitivity of a commercial, ceramic BeO exhibited itself as an intense peak at about 325°C during thermally stimulated exoelectron emission (TSEE). This activity was associated with the impurity silicon, concentrated in the surface region. The sensitivity was destroyed by etching the silicon from the surface region with HF but was restored by reimpregnation with SiO_2. Acids such as H_2SO_4 and H_3PO_4, which preferentially remove BeO rather than SiO_2, did not adversely affect the high sensitivity. It is suggested that substitutional Si^{4+} in place of Be^{2+} is the electron trap giving rise to the peak at 325°C. The previously reported heat sensitization of the ceramic at 1400°C and desensitization at 1500°C or higher are discussed in light of these findings. Other phenomena, such as self-excitation, are described. (auth)

Radiometric Instruments

Refer also to abstracts 8675, 9091, and 9237.

9400 (SAN-828-1) NUCLEAR INSTRUMENT LANDING SYSTEM. Phase I Final Report, September 1970-June 1971. Kaminskas, R. A. (TRW Systems Group, Redondo Beach, Calif.). 2 Oct 1971. Contract AT(04-3)-828. 110p. Dep. NTIS.

Development of the Nuclear Instrument Landing System (NILS) for providing highly accurate aircraft position information during the last phases of descent and touchdown is described. The system consists of beacons of radioisotope γ sources which are permanently installed at the airport and airborne equipment which consists of scintillation detectors and associated electronics. (W.H.K.)

9401 (TID-25850) REACTION CELL IMPROVEMENTS IN THE MERCURY SUBSTITUTION-NUCLEAR DETECTION SULFUR DIOXIDE STACK GAS MONITOR. [Final Report], March 18, 1970-October 14, 1971. Howes, James E. Jr.; Rosenberg, Harvey S.; Ewing, Robert A. (Battelle Columbus Labs., Ohio). 14 Oct 1971. Contract W-7405-eng-92. 38p. Dep. NTIS.

Industrial Nucleonics Corporation (IN) has designed and built a prototype instrument to measure SO_2 concentration in stack gas. SO_2 is reacted with a slurry of mercurous chloride to form a soluble sulfite-mercury complex. The quantity of mercury, and thus the quantity of SO_2, in the reaction solution is measured by X-ray absorption. A study to solve the operational problems of the SO_2 monitor reaction cell is described. A reaction cell system was developed which should operate satisfactorily in the IN instrument. The system consists of a 1-inch diameter × 1-$\frac{1}{4}$-inch-high bed of $\frac{1}{8}$-inch diameter × $\frac{1}{8}$-inch-long pellets of mercuric oxide through which are flowed the gas containing the SO_2 and a phthalate buffer solution (pH 6.05). The bed is operated in a flooded condition to assure good contact of the gas, liquid, and solid phases. Foaming and filtration problems are eliminated by the pelletized bed. Response time is improved to about 5 to 10 minutes since the liquid volume in the reaction cell may be reduced to about seven milliliters when a fixed reaction bed is used. (W.H.K.)

9402 (TKK-F-A-152) INTERFERENCE OF DIFFERENT ELEMENTS IN NEUTRON MOISTURE MEASUREMENT. Kasi, S. S. H. (Technical Univ. of Helsinki, Otaniemi (Finland). Dept. of Technical Physics). 11 Aug 1971. 26p. Dep. NTIS (U. S. Sales Only).

In connection with all kinds of neutron moisture measurements, the effect of a moderate amount of hydrogen dominates the slowing down process of neutrons in the energy range below 1 MeV, but the other common elements to be found in samples influence: (a) the slowing down at the energies of the source neutrons because of inelastic scattering, (b) diffusion (transport) during the slowing down process, (c) thermal diffusion, and (d) thermal absorption. This is illustrated by inspecting the cross section data. In addition some strongly absorbing elements, of which gadolinium is the most efficient one, interfere when thermal neutrons are detected. For a particular case some results are presented which have been obtained with a comparatively accurate computer program. The effect of the hydrogen bound in the dry matter is also discussed. (auth) (Finland)

9403 FUNDAMENTAL STUDIES ON RADIATION THICKNESS GAUGE. VI. RESPONSE FUNCTIONS OF IONIZATION CHAMBER AND RADIATION SOURCE. Koyanagi, Takami; Aida, Kazuo (Niigata Univ., Japan). Radioisotopes (Tokyo); 20: No. 11, 573-8(Nov 1971). (In Japanese).

The overall response function of the thickness gaging system composed of a radiation source and an ionization chamber is calculated theoretically on the simple principle known as "the rectilinear propagation of light." This function can be calculated from the response functions of each element of the system. In this system the source is at some distance, and the object is interposed between the source and the chamber, casting a blurred shadow on the chamber greater than itself. The response function of the ionization chamber or radiation source is experimentally obtained from the Fourier-transform of the differential of the transient response measured by scanning a shelter plate close to the surface of the subject. The response functions of cylindrical and spherical chambers with circular, square and rhombic windows and a radiation source (^{90}Sr) are obtained theoretically and experimentally. These two results are in good agreement. As to the overall response function, the theoretical values disagree with the experimental values. This must be caused by the effects of scattered β-rays. (auth)

9404 STABILIZATION OF SCINTILLATION COUNTER OPERATION. Szmanda, Wojciech. Elektronika; 12: No. 7, 279-82(1971). (In Polish).

Circuitry redesign was undertaken in connection with scintillation counters used with radioisotopes for density measurement. Automatic regulation of the amplifiers was added, which resulted in less sensitivity to interfering factors such as changes in the ambient temperature and supply voltage. (tr-auth)

9405 INVERSION SONDES IN THE SELECTIVE GAMMA-GAMMA METHOD. Artsybashev, V. A. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 128-34(1969). (In Russian).

A first attempt is made to provide a theoretical and procedural basis for noise-stable sondes in the selective gamma-gamma logging method, applicable to the use of ^{137}Cs, ^{60}Co, and ^{75}Se sources. Working formulas and numerical values of the constants entering into them are recommended for the preliminary choice of parameters of a double inversion sonde. Final compensation of the double sonde is accomplished experimentally by a proposed procedure. The requirements as to sturdiness of the basic elements of the sonde and accuracy of preparation of the lead collimators are estimated for optimal construction of the double sonde. (Geophys. Abstr.)

9406 RADIOISOTOPIC MONITOR FOR RIME ACCUMULATION. Fowler, W. B. (Pacific Northwest Forest and Range Experiment Station, Wenatchee, Wash.). Isotop. Radiat. Technol.; 9: No. 2, 182(Winter 1971-1972).

A radioisotopic gage, constructed to measure rime accumulation in high-elevation forests, is described. The gage uses a 2 to 3 μg of encapsulated ^{226}Ra and a halogen-quenched Geiger-Mueller counter. (W.H.K.)

9407 METODIKA I APPARATURA DLYA GIDROFIZICHESKIKH ISSLEDOVANII. (Methods and Instrumentation for Hydrophysical Studies). Paramonov, A. N. (ed.). Morskoi Gidrofizicheskii Institut, Vol. 41. Kiev; Izdatel'stvo Naukova Dumka (1969). 302p.

Thirty articles discussing instruments and techniques for measuring various parameters of the oceans and other natural waters are presented including radiometric instruments and radiation detectors. (C.E.S.)

9408 THICKNESS MEASUREMENTS OF ROLLED ALUMINUM SEMIFINISHED PRODUCTS BY MEANS OF NUCLEAR RADIATION. Langel, H.; Ritzler, H. Aluminium; 47: No. 3, 197-202(1971). (In German).

After a brief discussion of requirements which are necessary for thickness gages during production of foils and sheets, the X-ray method and the nuclear radiation method are compared. Using fluorescence radiation in connection with the high precision of modern electronic components, one can obtain sufficient measuring reliability during production. With regard to technical expenditure and operational safety, nuclear radiation gages exhibit essential advantages over X-ray devices. (INIS)

9409 DETERMINATION OF THE DENSITY OF ORES AND HEAVY ELEMENT CONTENT ON THE BASIS OF TWO CONJUGATE MEASUREMENTS OF SCATTERED GAMMA RADIATION. Artsybashev, V. A.; Ivanyukovich, G. A. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 135-40(1969). (In Russian).

The density and heavy element content in an ore were determined simultaneously by means of a graphical solution of a system of two experimental equations. A specific pair of conjugate measurements of the gamma field using two sondes was examined—

^{137}Cs source and scintillation detector with 2 mm Pb filter with a sonde length of R_1 = 30 cm, and ^{60}Co source and detector with 3 mm Al filter with a sonde length of R_2 = 20 cm. With these sondes the density of lead ores can be determined with a precision of ±2% and lead content with a precision of ±15%. (Geophys. Abstr.)

9410 APPLICATION OF THE GAMMA RADIATION ALBEDO TO THREE-DIMENSIONAL MEASUREMENT. Geger, V. Ya. (Bryansk Technological Inst., USSR). Defektoskopiya; No. 5, 75-9(1971). (In Russian).

The possibility of using gamma radiation albedo for determining the bulk weight of multicomponent media is examined for various depths in its dependence on measuring problems. The theoretical bases of gamma radiation albedo are presented. The influence of chemical composition and the ratio of components on the value of the effective Z for the structural material in question are discussed. A method is offered for establishing the density for different cross sections of the article by means of gamma radiation albedo. (tr-auth)

9411 GAMMA DEFECTOSCOPE PARAMETERS FOR THE SCINTILLATION METHOD. Vasil'ev, V. D.; Udralov, Yu. I.; Filippov, V. V. Defektoskopiya; No. 5, 70-4(1971). (In Russian).

A method of calculation of gamma defectoscope parameters is presented for the control of manufactured articles using a highly efficient scintillation counter for recording the radiation. The formula offered fixes the relation between the gamma defectoscope parameters by means of the control capacity and the minimum dimensions of defects which are revealed during inspection. (tr-auth)

9412 RADIOISOTOPE INSTRUMENTS IN ENVIRONMENTAL POLLUTION CONTROL. Tominaga, Hiroshi (Japan Atomic Energy Research Inst., Oarai). Genshiryoku Kogyo; 17: No. 8, 32-6; 53(Aug 1971). (In Japanese).

Though measurement with radioisotopes and radiation including tracers and neutron-activation analysis are applied to fields related to pollution directly or indirectly, there are only a few complete instruments now in practice or in development stage. Sulphur analyzers for fuel oil are one of the successful instruments in Japan which make use of X-ray absorption analysis. X-ray-absorption-type suspended-sediment concentration meters are also investigated in U. S. A. and Japan. Their practical application will be increased if effect of sediment composition and dissolved components can be decreased. Next, gamma density gauge is utilized in sewage plants and dredgers. Gamma or neutron logging is also employed for ground investigation. Meanwhile, X-ray fluorescence analyzer investigation, which employs radioisotopes as sources and semiconductor detectors as sensing heads, is being actively continued and expected for future possibility. "Activation analyzers" that can measure various elements together also have potential if the new radioisotope ^{252}Cf is put into practical use. (Japan)

9413 RADIOMETRIC INSTRUMENTS MADE IN ZMA OSTROV N. OHRI. Ryba, J. Radioisotopy; 11: No. 4, 673-8 (1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

Information on radiometric instruments made by ZRUP, the plant of mechanization and automatization in Ostrov nad Ohří, is presented. The instruments are intended for use in the uranium industry, however, some may be used in other branches and for work with radioactive material. (auth)

9414 MEASUREMENT OF PHYSICAL PROPERTIES SUCH AS WEIGHT. Gilbert, Paul (to Unilever Ltd.). British Patent 1,252,884. 10 Nov 1971. Filed 16 Nov 1967.

Reference is made to apparatus for the measurement of physical properties of materials by measurement of radiation absorption when the material is passed through a beam of radiation. The physical properties to be measured may be, for example, height of fill, density, weight per unit length, or total weight. The apparatus described comprises a radiation detector and at least two radiation sources spaced apart and arranged to provide a composite beam through which the material to be examined can be passed. The use of two sources enables a more rectangular beam to be obtained, giving fuller coverage of the material and better measurement efficiency. Methods of use and applications of the apparatus are described. (UK)

Miscellaneous Instruments and Components

Refer also to abstracts 9206, 9407, 9977, 10245, 10269, 10711, 10712, 10899, 10904, 11168, and 11388.

9415 (ARH-2047) CAPACITANCE PROBE INTERROGATOR INSTRUMENT DESCRIPTION AND MAINTENANCE MANUAL. Martin, G. E. (Atlantic Richfield Hanford Co., Richland, Wash.). Apr 1971. Contract AT(45-1)-2130. 40p. Dep. NTIS.

A capacitance probe detector for measuring the liquid level in a vessel such as the level of a radioactive solution in a sealed vessel is described. The circuit operation, calibration instructions, trouble-shooting, drawings, and fabrication procedure are discussed. (W.H.K.)

9416 (BNWL-CC-2520) ET-12 LINEAR CLAD THICKNESS TESTER. Davis, T. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. 33p. Dep. NTIS.

The ET-12 is a solid state eddy current tester designed specifically for nondestructively measuring the clad thickness of N-Reactor fuels. The tester incorporates a linearizing circuit to correct for the inherently nonlinear eddy current response to thickness of Zircaloy-2 cladding over uranium. It replaces the UE-2B testers which have been used since initial startup of the reactor. The ET-12 represents a vastly simplified model in comparison with the UE-2B. Its design requires no transformers, no inductive filtering, and employs a large array of integrated circuits, including audio powers amplifiers and internally compensated op amps. (auth)

9417 (CEA-CONF-1770) NUCLEAR MAGNETIC RESONANCE MAGNETOMETRY BY DOUBLE EFFECT ELECTRONIC PUMPING. Salvi, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 18 Mar 1971. 16p. (In French). (CONF-710321-1). Dep. NTIS (U. S. Sales Only).

From International conference on using the ocean; Bordeaux, France (9 Mar 1971).

A very brief review is given of the base phenomena governing the measurement of weak magnetic fields by the use of nuclear resonance. The concept of polarization is discussed. Its value is proportional to the field to be measured and for 0.5 oersted this coefficient is very small. The increase of the polarization necessary for a precise measurement of the field can be effected by two different methods: prepolarization and dynamic polarization. The concept of double effect polarization arose from the second method. Double effect polarization makes possible an isotropic magnetometer probe insensitive to ambient parasite electromagnetic perturbations. The advantages obtained by the nuclear oscillator are enumerated. (tr-auth)

9418 (CERN-71-27) DOUBLE THRESHOLD GENERATOR TYPE NP 2241. Delavallade, G.; Lindsay, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 1 Dec 1971. 8p. (In French). Dep. NTIS (U. S. Sales Only).

A generator was constructed to give a very time-precise threshold pulse. The circuits of the generator are given. (J.S.R.)

9419 (JAERI-Memo-4556) GAS TARGET FOR NEUTRON PRODUCTION. Yoshida, Tadashi; Maruyama, Michio (Japan Atomic Energy Research Inst., Tokyo). Aug 1971. 12p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The construction and the characteristics of a gas target are described which is used for neutron production with the JAERI 5.5-MV Van de Graaff accelerator. The target is of the double-window type, and is designed to produce monoenergetic neutrons and withstand the maximum pulsed beams from the accelerator. The fluctuation in integrated neutron yield can be kept within about 1%, if the variation of a current to the target is within 1 μA. (auth) (Japan)

9420 (RT/EL-(70)8) EXTRACTION OF A PERIODIC SIGNAL FROM NOISE. Cervellati, R.; Giomi, A.; Zagara, M.; Zippel, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Jan 1971. 33p. (In Italian). Dep. NTIS (U. S. Sales Only).

A simple sampling circuit has been realized which increases the signal to noise ratio by a factor of 7. It operates on a waveform which could be synchronized with the circuit itself at a repetition time of 100 μs. Some topics are discussed concerning the sampling technique and the methods suitable for a quantitative evaluation of the circuit behavior. (auth)

9421 APPLICATION OF ION IMPLANTATION IN MOSFET TECHNOLOGY. Saczuk, Krzysztof. Elektronika; 12: No. 8, 334-8(1971). (In Polish).

The advantages of ion implantation in MOS-field effect transistor technology are characterized. It is pointed out that the reduction of threshold voltage and gate-drain capacitance allows one to increase the operation speed in discrete and monolithic MOS circuits. The possible application of ion implantation in LSI structure technology is mentioned. (auth)

9422 THREE-DIMENSIONAL MULTICHANNEL ANALYZER WITH NONINTEGRATING MEMORY. Ivanov, I.; Dragnev, T.; Ormandzhiev, S. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 265-72(1971). (In Bulgarian).

For the purpose of the various correlation investigations of nuclear reactions a three-dimensional multichannel (256 × 256 × 256) analyzer with a nonintegrating memory is designed. When required, the dimension and number of channels can be increased. As an environment for storing the information, a paper tape is used; and as an output register, the tape punch FACIT PE 1501. The analyzer has an integral nonlinearity up to 0.25% and differential nonlinearity up to 1% at input amplitudes up to 70 volts. Its dead time is 53.6 ms. It is adjusted for work with a MINSK-2 electronic computer, but it can easily be rearranged for work with another machine that has a paper-tape reader as an input device. It can successfully be used at input intensity up to 100 triple pulses per second maximum. (auth)

9423 DESIGN OF A MASS SPECTROGRAPH FOR VELOCITY ANALYSIS: THE STUDY OF ION EMISSION FROM A METALLIC TARGET IN ULTRA HIGH VACUUM. Paletto, S.; Goutte, R.; Guillaud, C. (Institut National des Sciences Appliques, Villeurbanne, France). Vide; 26: No. 152, 63-8(Mar 1971). (In French).

The apparatus is described in detail and some experimental results are given. The limiting vacuum is of the order of 10^{-9} torr; various experiments were used to study simultaneously the mass spectra of emitted negative ions and the velocity spectra of the O^- ions released by several metallic targets. The ability to observe fine structures in the energy distributions of these ions is demonstrated. (France)

9424 SENSITIVITY AND ACCURACY OF ISOTOPIC-ABUNDANCE ANALYSIS USING AN ION-COUNTING METHOD. Ihle, H. R.; Neubert, A. (Kernforschungsanlage, Juelich, Ger.). J. Mass Spectrom. Ion Phys.; 7: No. 3, 189-208(Sep 1971).

A thermal ionization source mass spectrometer with ion counting using a multiscaler system is described, which allows periodic scanning of preselected mass ranges. Data are processed by an IBM 360/75. The evaluation of mass spectra obtained under various experimental conditions is discussed. Precision, accuracy, and sensitivity for isotope abundance measurements of some elements have been determined with samples from 10^{-6} to 10^{-10} g. For example, a precision of ±0.1% (standard deviation) is obtained with 2×10^{-9} g plutonium for isotopes of more than 30% abundance, whereas a precision of ±1% is found for isotopes in the 1% abundance range. The accuracy reached in measurements with 10^{-6} g samples of NBS uranium standards is better than ±0.5%. (auth)

9425 DEVICE USING ULTRASOUND FOR MEASURING DISPLACEMENT. Baron, Jean; Peronnet, Jean (to Commissariat a l'Energie Atomique). French Patent 2,055,999. 14 May 1971. Filed 18 Aug 1969. (In French).

An apparatus which uses ultrasound to measure the displacement of an object inside a fluid is presented. It may be used for measuring the vibration of mechanical components and also the movement of the level of the fluid. It was designed, in particular, for measuring the displacement of the mechanical components inside the liquid sodium coolant of a fast neutron reactor. It consists of two acoustic probes (a standard probe and a measuring probe), a circuit which produces electric signals that excite piezoelectric transducers, and a circuit receiving the signals emitted by the transducers. (France)

9426 MICROCHANNEL PLATES AND THEIR APPLICATIONS. Woodhead, A. W. (Mullard Research Labs., Redhill, Eng.); Eschard, G. Acta Electron.; 14: No. 2, 181-200(Apr 1971).

A microchannel plate is a compact array of channel electron multipliers which can be used for amplifying an electron beam containing spatial information. Some of the main characteristics of a channel plate are described, and some of its applications in a variety of devices are reviewed (x-ray radiography, neutron radiography, ultra-high-speed photography, night vision, cathode-ray tubes). From the point of view of these applications, the material and technological problems involved in the construction of a channel plate are mentioned. (France)

9427 FISSION GAS ANALYSIS AT THE HOT CELL. Womack, R. E. (Babcock and Wilcox, Lynchburg, Va.). pp 97-103 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A system for fission gas collection, analysis, and void volume determination has been developed at the Lynchburg Research Center. Gas analysis is performed using a quadrupole residual gas analyzer and the associated collection and aliquoting system. A turbomolecular pump provides the high vacuum necessary for this work. A volume substitution technique is used to determine capsule void volumes. This system has been used in analysis of gas from over 40 fuel pins and has demonstrated acceptable accuracy in the data produced. Efforts are underway to improve the reliability of its operation. (auth)

9428 REMOTELY OPERABLE PROFILOMETER FOR DIAMETRAL MEASUREMENT OF IRRADIATED AND UNIRRADIATED NUCLEAR FUELS. Carnes, M. D. (Argonne National Lab., Idaho Falls, Idaho). pp 118-23 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A remotely operable direct-contact gaging unit was built to measure the diameter of irradiated EBR-II fuel elements. It is an electronic gage using linear-voltage differential transformers as sensors. It produces a diameter profile by measuring diameter continuously over the element length. It can gage elements with or without spirally wrapped spacer wires. It is adjustable over a range of element diameters from 0.177 to 0.500 in. It is classed as a vertical unit because the element is maintained in a vertical position. Under in-cell operating conditions its uncertainty is $<\pm 0.0002$ in. When gaging calibration standards that are round in cross section and straight, the uncertainty of the measurement is $<\pm 0.0001$ in. (auth)

9429 INSTALLATION OF THE SHIELDED ELECTRON MICROPROBE ANALYZER AT OAK RIDGE NATIONAL LABORATORY. Long, E. L. Jr.; Miller, J. L. Jr. (Oak Ridge National Lab., Tenn.). pp 132-41 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A shielded electron microprobe analyzer was installed in the High-Radiation-Level Examination Laboratory (HRLEL), and a rapid method of transferring specimens was devised. This particular microprobe is a commercial unit that incorporates in the instrument design, shielding equivalent to a minimum of 8 in. of steel during specimen transfer into the microprobe as well as during analysis. Other facilities that use similar instruments (with Argonne being an exception), transfer specimens from the hot cells to the microprobe by specifically designed shielded carriers. A more rapid alternate means of transfer that provides additional capabilities was chosen. (auth)

9430 APPARATUS FOR DETERMINING HEAT CONTENT ON IRRADIATED FUELS. Frantz, C. E.; Schulte, J. W. (Los Alamos Scientific Lab., N. Mex.). pp 183-5 of Proceedings of the 19th Conference on Remote Systems Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1971).

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

A high-temperature drop calorimeter was installed in an alpha hot cell. In most respects the calorimeter is the same as that used in a typical out-of-cell installation. However, the device for dropping the sample capsule is of a new design which has worked well in the hot cell. Accurate temperature measurements of the sample in the furnace are made with an optical pyrometer located outside the cell. (auth)

9431 SEMIEMPIRICAL APPROXIMATION FORMULA FOR THE CALCULATION OF THE ENERGY AND DISTANCE DEPENDENCE OF THE HALF-WIDTH OF SINGLE-CHANNEL COLLIMATORS. Klein, J. (Medizinische Akademie, Magdeburg, Ger.). Isotopenpraxis; 7: No. 5, 175-80(May 1971). (In German).

In nuclear medicine, knowledge of the half-width of single-channel collimators which allows optimization of collimator adjustment is necessary to carry out external radiometric determination of the instantaneous or the time activity of some organ. Hitherto known hard-and-fast formulae for the determination even of purely geometric half-width characteristics differ from a precise half-width formula derived herein from geometric investigations. Introduction of the free parameter ζ into the solid angle setup rendered possible taking into account half-width increase due to the penetration of gamma-beams through the slots between lead bricks. Experimentally determined half-width values as a function of the distance between collimator front and source with varying gamma-energy of a point source were subjected to linear approximation rendering

possible determination of $\zeta = f(E_\gamma)$ values. Furthermore, errors in half-width caused by ζ, variation of half-width arising with transirradiation of tissue-equivalent matter (paraffin), and other error factors are discussed. (auth)

9432 SCALE OF A LOGARITHMIC SLIDE RULE FOR DETERMINING THE CHANGE IN THE ACTIVITIES OF RADIOACTIVE ISOTOPES IN AN UNLIMITED RANGE. Gavrik, V. Ya. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 760-3(Sep-Oct 1970). Translated from Radiokhimiya; 12: No. 5, 789-91(Sep-Oct 1970).

A special slide rule for calculations associated with radioactive decay and other spontaneous probability processes that obey an exponential law such as the attenuation of radiations during passage through matter is described. Together with the basic scales of the usual slide rule, this slide rule contains a one-period scale of the dependence of the relative residual activities as a function of the relative time of decay.

9433 MULTIPLE-FOCUSING TIME OF FLIGHT MASS SPECTROMETERS. PART I. TOFMS WITH EQUAL MOMENTUM ACCELERATION. Poschenrieder, W. P. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). J. Mass Spectrom. Ion Phys.; 6: No. 5-6, 413-26(Jun 1971).

New time-of-flight mass spectrometers (TOFMS) are described which combine stigmatic imaging with vanishing velocity dispersion in time-of-flight and imaging. In such analyzers the time-of-flight of an ion is a function of the mass-to-charge ratio only. Velocity focusing is achieved by combining linear drift spaces with sector fields. Mass spectrometers based on this principle will be capable of a mass resolution of several hundred and will be insensitive to initial ion energy spread. TOFMS with equal momentum acceleration are treated. (auth)

9434 CAMAC SYSTEM OF COMPUTER-GUIDED ELECTRONICS. INTRODUCTION AND PRESENT STATUS. Ottes, J.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 10, 516-19(Oct 1971). (In German).

The CAMAC system, as specified by most of the West-European and many of the East-European countries, was also adopted as standard by the USAEC. Modes of arrangement and operations for specification of CAMAC are outlined. It comprises three advantages: it permits the assembly of compatible modules; only the system controller is necessary for connection with the computer; and the necessary compatible software can be easily manufactured. Thus far, the CAMAC system has proven successful for laboratory automation and for scientific experiments. CAMAC courses at Karlsruhe showed increase in interest by industry. (tr-auth)

9435 DESIGN OF A WIEN FILTER AND MEASUREMENT OF LONGITUDINAL POLARIZATION OF BETA PARTICLES. Abhyankar, S. S.; Bhiday, M. R. (Univ. of Poona). Proc. Indian Acad. Sci., Sect. A; 74: No. 2, 53-61(Aug 1971).

Measurement of longitudinal polarization of beta particles is carried out for a pure beta source $^{204}Tl \rightarrow \beta \rightarrow {}^{204}Pb$ ($2 \rightarrow 0$ unique first forbidden) for $v/c = 0.6$ using a Wien-filter for transformation of polarization and Mott-scattering for the analysis of transverse polarization. The Wien-filter is most versatile for measurements to study the dependence of polarization with (1) the atomic No. Z, and (2) E the incident energy. The resolution of the Wien-filter arrangement reported is about 10% with sufficient transmission. The value of polarization is P_1 (1.09 ± 0.083) v/c which is in agreement with the theoretical value predicted for this transition. (auth)

9436 PERFORMANCE OF HIGH-GAIN FIRST-DYNODE PHOTOMULTIPLIERS. Morton, G. A. (David Sarnoff Research Center, Princeton, N. J.); Smith, H. M. Jr.; Krall, H. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 92-5(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The performance of photomultipliers having first dynodes of cesium-activated GaP with gains of from 30 to 50 is discussed. The resolution capabilities are high enough so that the pulse height distribution obtained from low intensity scintillations breaks up into separate peaks for one electron, two electrons, etc. This high resolution makes it possible to separate unwanted single electron dark pulses from the scintillation signal pulses very effectively. The full width at half maximum (FWHM) of a single electron pulse height distribution is typically 40% to 50%. Methods of measuring the resolution of these tubes are discussed together with some of the results obtained. These high gain dynodes appear to have good life characteristics. Their life and fatigue properties are as good or better than those of CuBe dynodes. (auth)

9437 EVOLUTION OF A COMPUTER SYSTEM FOR ACQUISITION OF ANGULAR CORRELATION DATA. Chalmers, R. A. (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 132-5(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A system using an SEL 810A computer programmed as a flexible multi-parameter analyzer is described. Features include a time-shared ADC channel with software gain correction for each input, unrestricted selection of spectra on any 2 of 4 input parameters, and live display of coincidence spectra with chance coincidences subtracted. (auth)

9438 MULTIPROGRAMMED OPERATING SYSTEM FOR NUCLEAR PHYSICS DATA ACQUISITION. Sachs, M. W. (Yale Univ., New Haven); Bromley, D. A.; Mikelsons, M.; Summers, P. D.; Birnbaum, J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 147-53(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A multiprogrammed operating system for nuclear physics data acquisition has been developed as part of a Yale/IBM Joint Study. The system supports multiple users in a fully protected environment. Features of the system include dynamic storage allocation, a fully reentrant supervisor, language and device independence, dynamic priorities, virtual device utilities, and extensive intertask communication facilities. An application example is presented. (auth)

9439 DATA COLLECTION INTERFACE USED BY THE BNL DATA ACQUISITION AND ANALYSIS COMPLEX. Schwender, G. E.; Rogers, P. C. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 162-4(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The Data Collection Interface used by the BNL Data Acquisition and Analysis Complex provides a convenient generalized means of interconnecting a series of unrelated devices into as many as eight logically independent arrays. For each array data are read from the devices, packed together to form convenient descriptor addresses and then transmitted to the computer to be stored in an independent spectrum of arbitrary size and number of dimensions. (auth)

9440 DIGITAL CONTROL SYSTEM FOR A NUCLEAR PHYSICS LABORATORY. Gingell, C. E. L. (Yale Univ., New Haven); Sachs, M. W.; Bromley, D. A.; Guido, A. A.; Birnbaum, J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 165-70(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

An integrated hardware–software system for monitoring and controlling experimental equipment in nuclear structure experiments at the Yale University Wright Nuclear Structure Laboratory is described. In this system, the control and monitoring of symbolically addressed devices is multiprogrammed with other tasks. Where possible, the details of a control operation are handled by an external control unit rather than by the computer itself. (auth)

9441 ULTRASONIC THERMOMETRY FOR NUCLEAR REACTORS. Lynnworth, L. C.; Carnevale, E. H.; McDonough, M. S.; Fam, S. S. (Panametrics, Inc., Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 184-7(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Ultrasonic thermometry, based on the temperature dependence of sound velocity in solids, has been demonstrated under ideal laboratory conditions beyond 6000 R. Integrated fluxes (nvt) of 2.6×10^{19} fast and 8.7×10^{19} thermal do not perturb the velocity/temperature relationship. Ta protective sheaths prevented carbon contamination for 1 hr at 5100 R, in a program simulating temperature measurements in the graphite/hydrogen atmosphere of a nuclear rocket engine. Tests have also been performed in liquid sodium at 1200 R, and separately, inside a 1.6 mm dia Ta tube heated to 5500 R, simulating temperatures inside UO_2-fueled pins of fast breeder reactors. (auth)

9442 PERFORMANCE TESTS ON AN EDDY-CURRENT FLOWMETER. Wiegand, David E.; Michels, Charles W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 192-5(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The eddy-current flowmeter seems well adapted to measurements in high-temperature liquid-metal systems, where deterioration of the properties of permanent magnets and other ferromagnetic parts or bearing problems may seriously degrade the performance of other types. Tests on an eddy-current flowmeter confirm the high signal levels and the optimum excitation frequency predicted by an analysis of the device. (auth)

9443 SMALL, LOW POWER PULSE HEIGHT ANALYZER WITH MEMORY FOR SPACE APPLICATIONS. Streeter, Gary R. (Space and Tactical Systems Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 371-5(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A space flyable multichannel analyzer with 4096 × 16 bit memory has been developed. The instrument's operational characteristics and unique thick-film construction are discussed. Foremost in the analyzer's specifications are a 200 milliwatt standby power consumption, typical differential linearity of ±0.2% over 98% of full scale, and physical dimensions of 3.25''H × 8.0''W × 6.75''D. (auth)

9444 HIGH-RESOLUTION RECORDING SYSTEM FOR NEUTRON CROSS-SECTION MEASUREMENTS USING AN UNDERGROUND NUCLEAR EXPLOSIVE SOURCE. Brown, W. K.; Furnish, A. P. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 411-18(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A high-resolution data recording system has been developed as part of the Los Alamos program of time-of-flight neutron cross-section measurements that use an underground explosion source. Analog signals from detectors near the targets are fed through logarithmic amplifiers, displayed one-dimensionally on fast-phosphor cathode-ray tubes, and are recorded on photographic film moving at high velocity at right angles to the CRT spot motion. The system is capable of tenth-microsecond resolution over a span of milliseconds, and three percent accuracy over a five-decade dynamic range. (auth)

9445 DETERMINING THE ISOTOPIC COMPOSITION OF URANIUM WITH THE AID OF A MASS SPECTROMETER. Alexandru, Gr.; Tufoi, N. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 7, 853-5(1971). (In Rumanian).

The isotopic composition of U is determined with the aid of the mass spectrometer. The improvements of the experimental equipment for obtaining intense ion beams are presented. (auth)

9446 ULTRASONIC DEVICE FOR DETECTING CHANGES IN THE TEMPERATURE OF A FLUID. Baron, Jean; Peronnet, Jean (to Societe d'Etudes Techniques et d'Entreprises Generales). French Patent 2,055,998. 14 May 1971. Filed 18 Aug 1969. (In French).

A device for detecting the variations in the temperature of a fluid using ultrasound is presented. The principle involves the detection of the variations in the transit time for an ultrasonic wave train propagating in a given direction. The device consists of an acoustic probe containing a piezoelectric pressure gage, a circuit producing the signals exciting the piezoelectric pressure gage, a circuit receiving the electric signals produced by the gage, and a commutation system. The apparatus is particularly suitable for monitoring the thermal behavior of the core of a nuclear reactor. (France)

9447 EXPERIMENTAL EVALUATION OF HIGH ENERGY ION IMPLANTATION GRADIENTS FOR POSSIBLE FABRICATION OF A TRANSISTOR PEDESTAL COLLECTOR. Ziegler, J. F. (IBM Watson Research Center, Yorktown Heights, N. Y.); Crowder, B. L.; Kleinfelder, W. J. IBM J. Res. Develop.; 15: No. 6, 452-6 (Nov 1971).

The use of ion accelerators to implant impurities in crystals has been limited mainly to low energies with acceleration voltages of 50 to 500 kilovolts. In this energy range, impurities are implanted into the upper micron or less of the surface. The present work describes certain characteristics of high-energy ion implantation. The boron and phosphorus ions were implanted into silicon with energies of 2 to 4 megavolts. In this energy range the impurities have a useful positive impurity concentration gradient from the surface. The surface concentration is about 4×10^{16} cm^{-3}, and the peak concentration exceeds 10^{19} cm^{-3} depending on dosage and occurs about 2.5 μm deep. After annealing the radiation damage, it was determined that the surface silicon recovered over 90% of its expected maximum conductivity and mobility. A discussion is given of the concentration gradients required to fabricate a collector pedestal for a high-speed switching transistor, and it is shown that such gradients can be obtained by using high-energy ion implantation. The pedestal may be implanted after the base and emitter diffusions, and annealed at a low temperature, thus keeping a sharp impurity gradient. Also, since it is put into the final epitaxial layer, its vertical position relative to the emitter-base junction will be independent of epitaxial undulations. (auth)

Radiation Effects on Instruments and Instrument Components

9448 (LBL-501) SURVEY OF RADIATION DAMAGE IN SEMICONDUCTOR DETECTORS. Goulding, Fred S.; Pehl, Richard H. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 20p. (CONF-711111-26). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

Examples of radiation damage in lithium-drifted detectors, lithium-drifted silicon detectors, and high-purity germanium detectors are discussed. The general patterns of damage, lithium-precipitation, annealing and recovery of detectors are outlined, and the observations are discussed. (auth)

9449 (SC-RR-710821) RADIATION EFFECTS CHARACTERISTICS OF CURRENT MOS DEVICES. Coppage, Floyd N. (Sandia Labs., Albuquerque, N. Mex.). Nov 1971. 22p. Dep. NTIS.

To determine if it is possible to obtain MOS devices which are tolerant to ionizing radiation, devices fabricated by several manufacturers were evaluated in both gamma rays and, in some instances, neutrons. This evaluation covered devices utilizing several different fabrication techniques, some of which were aimed at increasing the radiation tolerance. These data show that MOS devices which are very tolerant to radiation are possible and commercially available. (auth)

9450 GAMMA-RADIATION EFFECTS ON NICKEL: MAGNETOSTRICTIVE DELAY LINES. Kashukeev, N.; Ribarov, St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 141-7(1971). (In Bulgarian).

The gamma-radiation dependence of delay time and the size of the accepted signal of nickel magnetostrictive delay lines are investigated. ^{60}Co is used as a γ source at dose intensity 32.5 R/sec. The irradiations and measurements were made at room and liquid-nitrogen temperatures. The dependency of drop of the size of the signal assumed is experimentally obtained as a function of the γ dose. It is established that this characteristic of magnetostrictive delay lines is more strongly radiation sensitive in comparison with the delay time. A possible explanation of the effects observed is given from the point of view of the dislocation theory of the metals. (auth)

9451 MECHANISMS RESPONSIBLE FOR THE DAMAGE PRODUCED BY IONIZING RADIATIONS TO MOS TRANSISTORS WITH A P SUBSTRATE. Buxo, Jean; Esteve, Daniel; Therez, Francis (Centre National de la Recherche Scientifique, Toulouse). Compt. Rend., Ser. B; 273: No. 12, 436-9(20 Sep 1971). (In French).

The variation in the electron mobility inside the conduction channel of a MOS transistor with a P substrate is theoretically analyzed from the point of view of explaining the density of negative surface states appearing on exposure to radiation. The damage mechanism connected with charge carrier exchanges occurring at the heterogeneous SiO_2–Si junction is specified. (France)

9452 INVESTIGATION INTO THE EFFECTS OF INPILE RADIATION AND TEMPERATURE ON THE LEADWIRES OF CHROMEL-ALUMEL THERMOCOUPLES. Worsham, H. J. Jr.; Warren, H. D. (Babcock and Wilcox Co., Lynchburg, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 188-91(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The leadwires of Inconel-sheathed, Chromel-Alumel thermocouples were irradiated at levels up to 1.5×10^8 rad/hr gamma and 4×10^{13} neutrons/cm^2-s, and temperatures up to 700°F. The wires were 0.062 inch in diameter, and the junctions were maintained at 32°F. Although the radiation produced no effect detectable within a 0.2°F resolution, errors of 3°F maximum were induced by temperature gradients along the leadwires. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 8758.

Basic Processes

Refer also to abstracts 8675 and 9491.

9453 SIMPLE ROUTINE RADIOISOTOPIC METHOD FOR THE ESTIMATION OF SERUM VITAMIN B_{12} USING DEAE CELLULOSE AND HUMAN SERUM BINDING AGENT. Wagstaff, M.; Broughton, A. (Royal Air Force Inst. of Pathology and Tropical Medicine, Aylesbury, Eng.). Brit. J. Haematol.; 21: No. 5, 581-93(Nov 1971).

A simplified radioisotope method for serum vitamin B_{12} assay is described using pooled human serum as a binding agent and equilibrated DEAE cellulose as a separating agent. The normal range found was 185 to 1020 pg/ml and a probable significant difference between males and females was discovered. There was no overlap between the normal range and the pernicious anaemia range (30 to 160 pg/ml). Comparison of the method with microbiological assays (Euglena and Lactobacillus leichmannii) shows good correlation although minor variations between the methods were found and are discussed. The method was precise, economical with reagents and sera, and could easily be introduced as a new procedure in any routine laboratory. (auth)

9454 AUTOMATED RADIOMETRIC DETECTION OF MICROORGANISMS. DeLand, Frank H. (Johns Hopkins Medical Institutions, Baltimore). Isotop. Radiat. Technol.; 9: No. 2, 240-3(Winter 1971-1972).

A method is described for detecting the presence of specific bacteria causing infectious diseases in man, based on the release of $^{14}CO_2$ from glucose-^{14}C. (auth)

9455 RADIOISOTOPIC TECHNIQUE FOR STUDYING BIOLOGICAL SLIME-TREATMENT PROCESSES. Reid, George W. (Univ. of Oklahoma, Norman). Isotop. Radiat. Technol.; 9: No. 2, 244-5(Winter 1971-1972).

Apparatus for studying the effect of variables in slime treatment of sewage was constructed. Slime is deposited on a drum that rotates in a medium labeled with ^{32}P, and the activity of the drum is counted to determine the uptake of phosphorus by the slime. (auth)

9456 EVALUATION OF THE RATES OF BIOLOGICAL PROCESSES FROM TRACER KINETIC DATA. III. THE NET SYNTHESIS LEMMA AND EXCHANGEABLE POOLS. Koch, Arthur L. (Indiana Univ., Bloomington). J. Theor. Biol.; 32: 429-50(1971).

Equations are developed for total isotope incorporation into the sum of all species of RNA in growing bacterial cultures. The model is approximate in that it considers only one intermediate pool, only one messenger fraction, and only one intermediate on the path of the biosynthesis of the ribosome. However, there is no mathematical approximation involved in the treatment. With the aid of a computer, the conditions necessary to observe linear uptake with no lag were determined. It is concluded that exchange of exogenous isotopic precursor across the cell membrane, together with the existence of a turning over class of RNA, accounts for the observed smaller lag in isotope incorporation than that predicted from the size of the intermediate pool. The effect of amino acid starvation and turnover of precursors of ribosomal and transfer RNA is discussed. With the computer program, data from the literature are used to estimate the turnover rate of messenger RNA. (auth)

9457 EVALUATION OF THE RATES OF BIOLOGICAL PROCESSES FROM TRACER KINETIC DATA. IV. DIGITAL SIMULATION OF NUCLEIC ACID METABOLISM IN BACTERIA. Koch, Arthur L. (Indiana Univ., Bloomington). J. Theor. Biol.; 32: 451-69(1971).

A flexible computer program was set up to simulate the kinetics of the amounts of radioactivity and the amounts of substance in various classes of nucleic acids for a generalized biological system. This program works by transferring numbers from registers to other registers corresponding to the amounts of isotope label or the amount of substance moving from one pool or compartment to another for each successive time interval. It is practical to choose the time interval small enough so that the same results are accurately obtained with this type of computation as with the analytical solution for the most realistic and complicated case previously formulated. Much more complicated situations now can be treated with this recursion program and questions of relevance to current molecular biology can be answered. The questions treated in this paper are directed to enteric microorganisms and are: what are the conditions under which a short pulse reflects net synthesis and what are the conditions where it reflects total synthesis, what are the conditions that measurement of intermediate pool specific activity can yield information about the turnover and concentration of unstable macromolecules in the system, how prolonged can a pulse be and still label the species of RNA substantially in proportion to their rates of synthesis, and what are the amounts and rates of synthesis and degradation of ribosomal precursors best fitting data in the literature. (auth)

9458 ESTIMATION OF THE TOTAL POPULATION OF ALVEOLAR MACROPHAGES IN RATS. Sedaghat, B. (CEN, Fontenay-aux-Roses, France); Masse, R.; Nenot, J. C.; Lafuma, J.; Martin, J. C. Compt. Rend., Ser. D; 273: No. 2, 229-32(12 Jul 1971). (In French).

The total population of alveolar macrophages contained in the lung can be evaluated by the use of an appropriate technique of labeling with particles of hematite activated by neutron irradiation. The results show that the number of macrophages estimated in this way is more than twice that obtained by the usual lung washing techniques. (France)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 9479, 9482, 9484, 9485, 9492, 9493, 9524, 9532, 9533, and 9608.

9459 (BNWL-SA-4056) DEPOSITION PATTERNS AND THE TOXICITY OF TRANSURANIUM ELEMENTS IN LUNG. Sanders, C. L. (Battelle Pacific Northwest Labs., Richland, Wash.). [1971]. Contract AT(45-1)-1830. 32p. (CONF-710919-5). Dep. NTIS.

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971).

Data from a number of animal studies on the tissue distribution of inhaled $^{239}PuO_2$ particles are reviewed. It was concluded that cellular sites of plutonium localization and later redistribution of plutonium in the lung influences the toxicity of inhaled plutonium compounds. The loss of plutonium from macrophages, the death of macrophages, the engulfment of plutonium by the alveolar epithelium, and the sequestration of plutonium in foci of fibrosis accounts for the relatively long retention times for PuO_2 in the lung. The concentration of plutonium in particles, disproportionately in a few larger particles, in specific cellular elements of the lung and in subpleural, fibrotic areas of the lung, provides for high radiation dose rates in limited tissue volumes. Such concentrations of irradiation may result in the picture of epithelial metaplasia, preceding alveolo-bronchiolar carcinoma formation arising from Pu-laden areas of the lung. Such factors may be of great importance when determining the acceptable limits of exposure to man to airborne plutonium and other transuranic elements. (C.H.)

9460 (UR-3490-15) EFFECT OF AGE ON GASTROINTESTINAL ABSORPTION (Fe, Sr, Pb) IN THE RAT. Forbes, Gilbert B.; Reina, Julio C. (Rochester Univ., N. Y. School of Medicine and Dentistry). 1969. 19p. Dep. NTIS.

Young rats absorbed most of the orally administered dose of ^{59}Fe, ^{85}Sr, and ^{212}Pb from the gastrointestinal tract. At about the time of weaning, absorption abruptly dropped to the low level characteristic of the adult. The similarity of the age-absorption curves for Fe, Sr, and Pb suggests that a common maturation process is involved. With respect to Fe, the rate of maturation of the absorptive process can be influenced by the plane of nutrition at those ages when the transition from the infantile to the adult pattern is occurring, but not at earlier or later ages. Cortisone administration had no effect. (auth)

9461 EFFECT OF NICKEL FERROCYANIDE-ANION EXCHANGE RESIN AND SEVERAL METAL FERROCYANIDES ON THE ENHANCEMENT OF ^{137}Cs EXCRETION IN MICE. Matsusaka, Naonori (Iwate Univ., Morioka, Japan); Inaba, Jiro; Ichikawa, Ryushi; Enomoto, Yoshikazu; Watari, Kazuo. Hoken Butsuri; 6: No. 1, 15-19(Mar 1971).

Nickel ferrocyanide–anion exchange resin (NiFC–R) and several metal ferrocyanide compounds were tested to compare their effectiveness for eliminating ^{137}Cs from the body in mice. It was found that the NiFC–R was the most effective agent for the enhancement of ^{137}Cs excretion among those tested in this experiment. Therefore, it may be considered that NiFC–R is an effective antidote in cases of accidental incorporation of ^{137}Cs. (auth) (Japan)

9462 TISSUE DISTRIBUTION OF RADIOCESIUM IN THE MULE DEER. Hakonson, T. E.; Whicker, F. W. (Colorado State Univ., Ft. Collins). Health Phys.; 21: No. 6, 864-6(Dec 1971).

The tissue distribution of ^{134}Cs was studied in six captive adult and fetal mule deer. Single oral administrations of $^{134}CsCl$ in the dose range 20 to 190 μCi were given via the drinking water and sacrifice was after 10 to 19 days. Skeletal muscles contained the highest concentrations, with a mean value of 1.21% of the initial oral intake per kilogram of tissue. The highest organ concentrations were found in the kidney and heart, which averaged 0.81% and 0.65% per kg. Bone and marrow contained 0.23% and 0.02% per kg. Muscle concentrations averaged 78% of the total body burden, bone contained 4%. Lungs and liver contained approximately 1% and the remaining tissues each had less than 1%. In two females, 5 to 6% of the total burden was deposited in fetal tissue. Deposition in fetal skeletal muscle was 53% of the body burden compared to 75% in the muscle of the dams. The fetal skeleton retained two to five times more ^{134}Cs when results were expressed as a percentage of the total body burden. (UK)

9463 RETENTION AND DISTRIBUTION OF INJECTED ^{252}Cf IN THE RAT. Mewhinney, J. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.); Ziemer, P. L.; Landolt, R. R. Health Phys.; 21: No. 6, 857-9(Dec 1971).

Male rats were injected peritoneally with 1.0 Ci ^{252}Cf and whole-body retention and distribution in the following areas studied for up to 64 days: kidney, liver, gastrointestinal tract, spleen, femur, carcass, soft tissue, and skeleton. Half lives were calculated using least squares techniques. Bone sections from the femurs were prepared for autoradiography and a time sequence mapped for ^{252}Cf deposition. Californium-252 appeared to deposit to a greater extent than ^{239}Pu on periosteal surfaces, although the endosteal deposition was also significant. (UK)

9464 UPTAKE AND EXCRETION OF ^{60}Co BY BLACK BULLHEADS ICTALURUS MELAS (RAFINESQUE). Reed, James R. (Oak Ridge National Lab., Tenn.). Health Phys.; 21: No. 6, 835-44(Dec 1971).

Black bullheads were able to accumulate ^{60}Co from water. During uptake, the gills contained from 19 to 30% of the whole-body ^{60}Co activity. After 3 days of ^{60}Co uptake, the flesh accounted for 16% of the total activity. Fish dosed in a single feeding lost 95.5% of the initial activity in one day of excretion, whereas fish that were exposed in ^{60}Co-dosed water lost 28% of the initial activity during the first day of excretion. Elimination of ^{60}Co after intake from water or from food occurred in three components. The initial rapid loss of activity after uptake from food had a biological half-life of 1.5 days, compared to 3.4 days for the initial component after uptake via water. The intermediate components had biological half-lives of 35 and 40.5 days, respectively, after water uptake and after food uptake. The third components in both cases had long, undetermined biological half-lives. Radiocobalt and stable cobalt analyses showed that the blood and blood-rich organs, particularly the kidney, were principal sites of cobalt concentration. (auth)

9465 EFFECT OF RADIOPHOSPHORUS ON THE POST-NATAL DEVELOPMENT OF LIVER IN SWISS ALBINO MICE. Sen-Gupta, Mamta; Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 142: No. 3, 360-4(Sep 1971).

One day old Swiss Albino mice were injected with carrier-free radiophosphorus in the form of sodium orthophosphate in isotonic saline containing phosphate buffer. The dose rate was 1.0 μCi/g body weight. The autopsies were carried out at the intervals of 1,2,3,4,5 and 6 weeks after the date of P-32 administration. The maximum damage was seen at three weeks. Cytoplasmic vacuolation and degranulation are prominent. Chromatolysis in the nuclei is very much pronounced. This was followed by a tendency towards recovery which is again overshadowed by a relapse at 6 weeks. (auth)

9466 EFFECT OF GLUCAN ON RADIOCERIUM METABOLISM IN RATS. Trnovec, Tomas; Pleskova, Anna; Chorvat, Dusan; Vladar, Milan (Inst. of Industrial Hygiene and Occupational Diseases, Bratislava). Strahlentherapie; 142: No. 3, 353-9(Sep 1971).

The disappearance of ^{144}Ce in blood applied intravenously in solution of pH 3 and pH 8, and its organ distribution in rats were studied in relation to reticuloendothelial stimulation with glucan. After the application of glucan an enhanced carbon clearance and no changes in ^{131}I-rose bengal clearance have been observed. While there were no changes in ^{144}Ce pH 3 clearance, the disappearance of ^{144}Ce pH 8 from blood in glucan-stimulated rats was faster. The 24-hour distribution of ^{144}Ce pH 3 in stimulated rats was shifted towards liver and spleen. Repeated glucan administration after ^{144}Ce pH 3 and pH 8 intravenous application had no effect on ^{144}Ce body distribution and its excretion pattern. In experiments reported glucan did not prove to be useful for decorporation of ^{144}Ce. (auth)

9467 EXPERIMENTAL STUDY OF ALVEOLAR CLEARANCE. Lafuma, J. (CEN, Fontenay-aux-Roses, France). J. Biol. Med. Nucl.; 6: No. 24, 20-3(1971). (In French).

A method of analyzing lung clearance in animals is described. Animals are made to inhale activated (^{59}Fe) hematite particles. The γ activity of the animals is measured externally and in toto over a period of several weeks. Changes in the count rate faithfully represent lung clearance. The method is very general and may be used to investigate the action of any agent suspected of having an effect on lung clearance. The method is valuable for studying the effect of substances administered by injection in addition to those inhaled, and it is independent of the nature of the action of the causal agent. (France)

Radiation Effects

Refer also to abstracts 9542, 9623, 9627, 9629, 9651, 9664, 9682, and 9684.

9468 IRRADIATED PECTIN AS A SUBSTRATE FOR PECTIC ENZYMES. Romani, R. J.; Somogyi, L. P.; Manalo, Juanita (Univ. of California, Davis). Contract AT(11-1)-34. Radiat. Bot.; 11: No. 5, 383-7(Oct 1971). (UCD 34P112-39).

Gamma irradiation of a 1% pectin solution with doses up to 250 krad increased the susceptibility of the pectin to pectin methylesterase and decreased its susceptibility to pectin-polygalacturonase and pectin-transeliminase. Major physicochemical changes occurred in the 500 to 1000 krad dose range as revealed by a rapid decrease in susceptibility to all three enzymes. Irradiation under anoxic conditions did not significantly alter the radiation effect. (auth)

9469 ANALYSIS OF GAMMA-INDUCED DNA BREAKS REPARABLE WITH POLYNUCLEOTIDE LIGASE. Gaziev, A. I.; Fomenko, L. A.; Sukhoruchkina, L. V.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino-na-Oke, USSR). Dokl. Akad. Nauk SSSR; 199: No. 1, 216-18(1 Jul 1971). (In Russian).

The chemical nature of the terminal groups arising from a break in a DNA molecule as a result of ionizing radiation was previously investigated and they were found to be largely phosphate groups. Quantitative ratios of polynucleotide ligase-repaired phosphate breaks and unrepaired phosphate breaks in DNA as a function of radiation dose are reported. This ratio proved to be a linear function of the amount of radiation received. Labeled DNA was obtained from Bacillus subtilis cultures grown in a medium containing ^{32}P. The calculations are based upon the quantity of radioactive P released by alkaline phosphatase from a given specific activity of labeled DNA by various doses of ^{137}Cs γ radiation. (K.S.W.)

9470 CHANGES IN HEPATIC BIOCHEMICAL ACTIVITY AFTER INTRAVENOUS ADMINISTRATION OF COLLOIDAL GOLD (^{198}Au). Gheorghe, N. Rev. Roum. Physiol.; 8: No. 3, 293-7(1971). (In French).

The modifications induced in hepatic biochemical activity, chiefly at the level of the principal cellular compounds metabolically active, by ionizing radiation emitted by colloidal gold (^{198}Au) in doses of 15 μC/100 g weight were studied. The results demonstrated the disappearance of pyruvic and oxaloacetic ketoacids and a decrease in α-ketoglutaric acid in the liver of animals sacrificed 2 and 24 hrs after the i.v. injection of colloidal ^{198}Au. This causes alterations in the dynamics of the intermediate constituents of the tricarboxylic acid cycle. A decrease in the total lipids, neutral fats, and oleic acid, and an increase in spingomyelin were established. The purine and pyrimidine bases of hepatic nucleic acids and the amine acids of water soluble proteins isolated from the liver were not altered significantly. (tr-auth)

9471 X RADIATION OF DESOXYRIBOSENUCLEIC ACID IN VITRO AND IN VIVO. Limperos, George. Newark, Del.; Univ. of Delaware (1949). 115p. University Microfilms Order No. 71-27,594.

Thesis.

Desoxyribosenucleic acid (DNA) was depolymerized in aqueous solution by chemically generated free radicals as well as by x-radiation; thiourea inhibited depolymerization by both means. These results were interpreted as evidence for an indirect mechanism for x-radiation of DNA in aqueous solution, mediated through the production of free radicals from the solvent. The extent of the depolymerization was determined by the measurement of the structural viscosity, streaming birefringence, and the sedimentation constants of the DNA solutions. Additional evidence for the indirect mechanism was obtained by the inability to depolymerize DNA in a dry state, in ethylene glycol, or in a frozen aqueous so-

lution by x-radiation. The "in vivo" x-radiation of rat thymus DNA produced two different effects. It was found that when the animals were sacrificed immediately after irradiation, the DNA extracted from the thymus was low in nitrogen due to a splitting off of purine bases. This was confirmed by the analysis of the purine N/pyrimidine N and also by the ultraviolet absorption spectra of the DNA solutions. When the animals were sacrificed twenty-four hours after irradiation, the structural viscosity, streaming birefringence, and the sedimentation constants of the DNA solutions revealed that the DNA was almost completely depolymerized. Thiourea, injected before irradiation, did not inhibit the splitting off of the purine bases from the DNA but did inhibit the depolymerization to some extent. Possible mechanisms for these reactions are suggested. The survival rate of mice exposed to x-radiation was increased if, before irradiation, thiourea was injected into the animals or was added to the drinking water. (Diss. Abstr. Int., B)

9472 EVALUATION OF ABILITY OF IRRADIATED CELLS TO RESYNTHESIZE AND UTILIZE ATP IN VIVO. Voskoboinikov, G. V. (Central Scientific-Research Roentgeno-Radiological Inst., Leningrad). Vop. Med. Khim.; 17: No. 5, 492-8(Sep-Oct 1971). (In Russian).

Effects of 1000 R x radiation on resynthesis of ATP following phosphorylation of exogenous AMP or adenine were studied; no effects were found during a two-day period. Additional administration of NACN or DNP to animals inhibited oxidative resynthesis of ATP in the liver of both control and irradiated animals. Dynamics of accumulation of S-adenosylethionine in tissues of rats given ethionine indicate that enzymatic activation of analogs of methionine and intensity of ATP utilization in the liver of irradiated rats persist at the control level. (auth)

9473 UNSCHEDULED DNA SYNTHESIS IN HUMAN LEUCOCYTES. Connor, W. G.; Norman, A. (Univ. of Wisconsin, Madison. Univ. of California, Los Angeles). Mutat. Res.; 13: No. 4, 393-402(Dec 1971).

Polymorphonuclear leucocytes have been induced to synthesize new DNA by exposure to uv light. Preliminary observations (not included) also indicate that 6-MeV electrons and incubation with the radiomimetic agent methyl methane-sulfonate (MMS) are effective agents for inducing unscheduled DNA synthesis (UDS). A study of the kinetics of uv-induced DNA synthesis suggests that there are at least two processes operating, one fast and essentially complete within the first 1-2 h and the second lasting at least 8 h. The rapid process can be described by a simple enzyme model using [^{3}H]-thymidine and induced lesions as substrates. A kinetic study of the rapid process, following exposure to uv, yielded values for the maximum velocity of $5.1 \cdot 10^{-21}$ moles/cell-h and $5.5 \cdot 10^{-20}$ moles/cell-h for the granulocytes and lymphocytes respectively. The rate constants for the rate-limiting steps were $1.4 \cdot 10^{-1}$ $(min)^{-1}$ and $1.1 \cdot 10^{-1}$ $(min)^{-1}$ for granulocytes and lymphocytes respectively. Using these values, the concentration of enzyme molecules are estimated to be $4 \cdot 10^3$ molecules/cell for polymorphonuclear leucocytes and $5 \cdot 10^4$ molecules/cell for lymphocytes. (auth)

9474 EFFECT OF RADIATION ON DEOXYRIBONUCLEOPROTEINS IN ANIMAL TISSUES. V. ACTION OF VARIOUS POLYANIONS ON DEOXYRIBONUCLEOPROTEIN OF MOUSE SPLEEN AND THYMUS AFTER IRRADIATION. Matyasova, Jitka; Skalka, M.; Cejkova, Milena; Blazicek, G. (Inst. of Biophysics, Brno). Folia Biol. (Prague); 17: No. 5, 328-39(1971).

Interaction of some polyanions of polysulphate type with the suspension of chromatin, i.e. crude deoxyribonucleoprotein (DNP), from mouse spleen and thymus in 0.14 M NaCl leads to the solubilization of a part of the DNP complex. The studied polyanions can be divided into two groups, as to their behavior to DNP, weakly reacting polyanions (heparin and polypentose sulphate) and strongly reacting ones, i.e. polyethylene sulphate, polyvinyl sulphate and dextran sulphate. When reacting with polyanions of the first group, the DNP from irradiated tissues is several times more sensitive than DNP from normal tissues. In the fraction of DNP, solubilized by incubation with these weakly reacting polyanions, the relative amount of proteins is higher than in the fraction of DNP, solubilized with polyanions of the second group. When strongly reacting polyanions interact with mouse spleen and thymus DNP, the difference between DNP from irradiated and unirradiated tissues is smaller. As shown by the chromatographic analysis on Sephadex G 200 column, using 0.14 M NaCl as eluant, the molecular weight of the fraction of DNP, which is solubilized by the action of polyanion, is higher than 200,000. The first peak appearing at the void volume of the column contains DNA, protein, and polyanion. This indicates that a complex between DNA, protein, and polyanion is formed during the interaction of DNP with polyanion. The formation of a complex between DNP and polyanion is further supported by experiments with polypentose sulphate as well as with heparin labelled with ^{3}H, and finally, by experiments attempting to separate the first peak components on Sephadex G 200 column after their deproteinization with phenol. (auth)

9475 EFFECT OF THORIUM ON THROMBIN. THE ROLE OF CARBOXYL GROUPS. Colman, Robert W. (Massachusetts General Hospital, Boston). J. Biol. Chem.; 246: No. 14, 4497-4503(25 Jul 1971).

Both the proteolytic and esterolytic activity of thrombin were destroyed by as little as 50 μM thorium chloride. The inhibition of thrombin was prevented by anions complexing thorium and potentiated by substrate, calcium, or lowering of the pH of the reactive mixture. The thorium-treated enzyme showed a decrease in V_m but not K_m and a shift in its pH activity profile to a more alkaline range. In order to ascertain whether carboxyl groups were involved in this reaction with $ThCl_4$, the carbodiimide-nucleophile reaction was studied. Progressive inactivation of thrombin with marked potentiation by calcium and substrate were observed similar to the reaction with thorium. Eight moles of ^{14}C-glycine ethyl ester per mole of protein were incorporated under nondenaturing conditions in the presence of low concentrations of 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide with 80% loss of activity. When thorium-treated enzyme was similarly treated with carbodiimide, less than 1 mole of glycine ethyl ester was incorporated, suggesting that similar carboxyl groups were also involved in the modification by thorium. The accessibility of the free carboxyl groups whose integrity appears essential to the enzymatic function of thrombin seems to be critically dependent on conformational changes in the molecule. (auth)

9476 RADIODENATURATION OF DNA. Uliana, R.; Creac'h, P. V.; Ducastaing, A. (Univ., Bordeaux). Biochimie; 53: No. 4, 461-8(1971). (In French).

The radiodenaturation of DNA was simultaneously studied by different methods: Rayleigh scattering, ORD and CD, and column chromatography. It was shown that the degradation of the molecule occurred more quickly than the loss of its helicity. The purine and pyrimidine degradation depends on the radiodestruction of H-bonds in the molecule. (France)

Immunology

9477 (EUR-4663) INVESTIGATIONS ON BONE MARROW TRANSPLANTATION IN IRRADIATED ANIMALS. Final Report. Balner, H. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut). 1971. 13p. Dep. NTIS (U. S. Sales Only). EUR FF 4.45.

In the period covered by the present report, the identification of primate leukocyte antigens was continued and a number of new candidate leukocyte antigens were added. In addition, the study of erythrocyte groups and their significance for transplantation immunology was initiated. During 1966, a major advance in the control of secondary disease was achieved by the introduction of anti-lymphocyte serum to treat the bone marrow recipients after the transplantation. In 1967 most of the efforts concentrated on the procedure for the production and purification of the agent. Major progress was made by finding that anti-human lymphocyte serum is highly immunosuppressive in chimpanzees, which enables a more rational evaluation of the agent for clinical purposes. The studies concerning the radiosensitivity of the immune system have concentrated on the recovery process after irradiation and on the role of the macrophages in the initiation of the immune response. (auth)

9478 SYNTHESIS OF IMMUNOGLOBULINS BY RAT THYMUS AFTER THYMIC IRRADIATION. Ghossein, N. A.; Tricoche, M. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Nature (London New Biol.); 234: No. 44, 16-17(3 Nov 1971).

Four week old male Sprague Dawley rats were locally irradiated over the thymus with one dose of 3000 rads. Two weeks later the thymus glands were removed and incubated for 3 hrs in Eagle's minimum essential medium containing ^{14}C-labelled material. After incubation, a tritiated reference marker of 7S gamma globulin from MPC-11 mouse plasma cell tumors was added and active synthesis of 7S gamma globulin was demonstrated by electrophore methods. The globulins were presumed to come from plasma cells present after local irradiation. (UK)

Ecology

Refer also to abstracts 9523, 9525, 9536, 9537, 9539, 9556, 11325, and 11406.

9479 (CONF-710501-45) TRITIUM BEHAVIOR IN FISH FROM A CHRONICALLY CONTAMINATED LAKE. Elwood,

J. W. (Oak Ridge National Lab., Tenn.). [1971]. 13p. Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Tritium behavior in fish from chronically contaminated White Oak Lake was studied under field and laboratory conditions to determine distribution and biological turnover. Bluegill (Lepomis macrochirus) from an uncontaminated lake were placed in White Oak Lake and assayed for tritium over a 36-day period. Concentration ratios (tritium concentration in lake/tritium concentration in fish) for whole body and body water tritium ranged from 0.6 to 0.9 and 0.8 to 1.0, respectively. Turnover of tissue bound and body water tritium was measured in goldfish (Carassius auratur) from this lake after placing them in uncontaminated water in the laboratory. Body water tritium was eliminated at two exponential rates with biological half-lives of 0.2 and 0.9 hours. The initial fast component represented 96% of the initial level of body water tritium. Tissue-bound tritium was eliminated at a single exponential rate with a biological half-life of 8.7 days. Under long-term chronic exposure to tritium in food and water, fish do not appear to concentrate it in either their body water or tissue-bound components. Varying concentrations in lake water, which resulted in non-equilibrium conditions between tissue water and bound tritium in fish and lake water at the time fish were assayed for tritium, appeared to be the reason for concentration ratios greater than one in bluegill chronically exposed throughout their life history. (auth)

9480 (EUR–4701) STUDIES ON THE RADIOACTIVE CONTAMINATION OF THE SEA. Annual Report, 1970. Bernhard, M. (Comitato Nazionale per l'Energia Nucleare, La Spezia (Italy). Laboratorio per lo Studio della Contaminazione Radioattiva del Mare). 1971. 84p. (RT/BIO–(71)4). Dep. NTIS (U. S. Sales Only). EUR FF 13.80.

The Seventh Annual Report of the CNEN-Euratom Contract of Association is presented. The program laid down in this contract calls for studies of the factors that influence the distribution of radioisotopes and stable isotopes in the marine environment. The program is divided into two parts: relevant environmental factors in the Ligurian Sea and in the Gulf of Taranto, where the Italian fuel processing plant will be constructed; and the influence of environmental factors on the uptake, accumulation, and loss of radioisotopes by components of the marine environment. The task of carrying out this program was divided between five groups: chemistry, botany, zooplankton, microbiology, and special developments. An account is given of the results obtained by these groups in 1970. (auth)

9481 (NIRS-RSD–31) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). May 1971. 18p. Dep. NTIS (U. S. Sales Only).

Meteorological data are presented in the form of tables showing monthly deposits of ^{137}Cs and ^{90}Sr from rain and fallout dusts and a map is presented to show sampling stations. Dietary data for ^{137}Cs and ^{90}Sr are also tabulated to show content of vegetables from April, 1970, to January, 1971, and content of tea from May to August, 1970. Source water from 25 sampling locations was analyzed for ^{137}Cs and ^{90}Sr and results obtained from April, 1970, to March, 1971, are tabulated. A table is also presented to show content of potable rain water used by lighthouses from May, 1970, to January, 1971. Concentrations of ^{137}Cs and ^{90}Sr in marine fish are tabulated for November, 1966, to November, 1970. (H.L.W.)

9482 (NYO–2174-115) ^{239}Pu IN SOME MARINE ORGANISMS AND SEDIMENTS. HASL Fallout Program Quarterly Science Report. Wong, K. M.; Noshkin, V. E.; Surprenant, Lolita; Bowen, V. T. (Woods Hole Oceanographic Institution, Mass.). May 1970. Contract AT(30-1)-2174. 7p. Dep. NTIS.

Data from a number of studies on ^{239}Pu uptake and retention by marine animals and sediments and the content of ^{239}Pu in sea water samples from various locations are reviewed. It is concluded that most of the Pu released to the near-shore marine environment concentrates in sand and silts of the sea floor and beaches. Data on Pu uptake and retention by fish, shellfish, plankton, and algae in the sea indicate that significant concentrations of Pu occur in these organisms. The possibility that Pu concentrations on sands or shallow marine sediments may be taken up by bottom feeding marine organisms and in turn taken up by food fish and crustaceans that prey on bottom feeding organisms is discussed. Preliminary results of analysis of near-shore water samples before and after passage through pipe lines indicate that Pu loss from sea water may involve some active process rather than adsorption to surfaces. (C.H.)

9483 (UCLA–12-848) ECOLOGICAL ASPECTS OF PLUTONIUM DISSEMINATION IN TERRESTRIAL ENVIRONMENTS. Romney, E. M.; Davis, J. J. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology. Nevada Operations Office (AEC), Las Vegas). [1971]. Contract AT-04-1-GEN-12. 17p. Dep. NTIS.

The technology of plutonium production and processing is already established, but the realization of its peaceful applications depends largely upon the development of methods for preventing its distribution in the environment. Because of safeguards and effective control measures, no accidental plutonium contamination of the public domain has imposed serious risks to a population group. Trace amounts of plutonium from above-ground nuclear detonations are contained in worldwide fallout; however, the levels of plutonium in foodstuffs and other components of the environment are insignificant compared to the amounts known to be hazardous. There has thus been very little interest in the study of ecological aspects of plutonium contamination. The result is a paucity of information on the behavior of plutonium in ecosystems and its radiological effects on natural fauna and flora. A program at the Nevada Test Site to investigate the long-range effects of plutonium disseminated into the desert ecosystem is outlined. Emphasis will be placed upon standardization of analytical methods, delineation of contaminated areas, problems of resuspension and redistribution, food chain transport, and ecological effects. (47 references.) (C.H.)

9484 (UCRL–72930) TRITIATION OF AQUATIC ANIMALS IN AN EXPERIMENTAL FRESHWATER POOL. Harrison, Florence L.; Koranda, John J. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Aug 1971. 35p. (CONF-710501–40). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

The transfer of tritium from tritiated water to representative aquatic organisms was studied in a freshwater ecosystem. Freshwater clams, crayfish, and goldfish as well as cattails and filamentous algae were maintained in a 2000-gallon freshwater pool to which tritiated water was added to an initial concentration of 1.6×10^6 dis/min per gram hydrogen. The concentrations of tritium were determined for 8 months in the pool water and in the water and organic matter of the tissues of the organisms. During the experimental period, the concentration of tritium in the pool water decreased exponentially to 3.2×10^5 dis/min per gram hydrogen due to the replacement of evaporated water with nontritiated water. In the tissue water of the biota, tritium increased rapidly to 95% of the level in the pool water and remained at about that level for the duration of the experiment. The organically bound tritium was higher in concentration in the photosynthetic organisms than in the animals and was higher in algae than in cattails. In the animals, the organically bound tritium was highest in concentration in the visceral organs and lowest in the calcified tissues. In the visceral organs, the specific activity (tritium/hydrogen) of the organically bound tritium increased to a maximum of about 60% that of the tissue water. In the muscle tissue, it increased to a maximum of about 30% that of the tissue water. The dose to the animals living in the pool system approximated 5 rem per year. No adverse effects of tritium were observed in these animals. The integrated whole-body dose to man from the one-time consumption of one kilogram of animal tissues having the average tritium concentration used in these experiments would be approximately 4 mrem. (auth)

9485 (UCRL–73178) MOVEMENT OF TRITIUM IN ECOLOGICAL SYSTEMS. Koranda, John J.; Martin, John R. (California Univ., Livermore. Lawrence Radiation Lab.). 24 Aug 1971. 56p. (CONF-710809–10). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

Tritium movement in ecological systems is complex, involving many physical and biological compartments. The uptake of THO water and vapor occurs rapidly in plants and animals, but because of the rapid turnover of body or tissue-water in living organisms, the half-times are generally short. Plant half-times may be measured in minutes or hours, while animal body-water half-times are one to two days to 15 days. In plants, organic fixation of tritium occurs even in exposures of short duration and the half-time of tissue-bound tritium is considerably longer than that in tissue-water. Tritium movement in soils is affected by soil characteristics, such as, bulk density, and the displacement of the THO pulse within the soil system by subsequent increments of rain or irrigational water. Intermediate to long half-times are observed in soil systems with the major factors affecting loss rates being porosity and rainfall rate. In well-drained, porous soils, vapor losses may be effective in dissipating tritium pulses while in denser soils with higher rainfall rates, leaching of soil water is the dominant factor. The half-time of tritium in plants growing on tritium-contaminated soil is extended by the longer half-time in the soil. The root zone of the plant will contain tritium for

varying lengths of time depending upon rainfall rate and soil characteristics. Aquatic organisms acquire tritium rapidly from their medium and some fraction of the tritium in the tissue-water exchanges or becomes incorporated into the tissues of the animals. Higher burdens of tissue-bound tritium will be seen when tritium is acquired from the food chain than when only the medium is contaminated. A comparison of the climatic characteristics of the desert and tropical environments and the environmental half-time of tritium in those ecological systems allows some broad generalizations to be made. One might expect an ecological sequence of tritium half-times in a series of environments ranging from arid desert to wet tropics, but the physical characteristics of the soil system, the relationships between the soil and the parent material, and the distribution of rainfall will exert a strong influence on the details of water and tritium movement in an environment. Data are included from a study on tritium distribution and retention in tissues and tissue water of red oats (Avena sativa), corn (Zea mays), sunflower plants (Helianthus annua), and black pine (Pinus thumbergii) at various times following a single vapor exposure of the plant or uptake from soil. (34 references.) (C.H.)

9486 (UCRL-73373) SYSTEM FOR CORRELATING TRITIUM OXIDE TRANSPORT IN VEGETATION WITH MICROMETEOROLOGICAL VARIABLES. Clegg, B.; Koranda, J.; Hadley, G. (California Univ., Livermore. Lawrence Radiation Lab.). 2 Nov 1971. 6p. (CONF-711111-20). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

Likely increases of atomic power production will result in releases of more tritium (^3H) to the environment. This low energy beta emitter (half-life of 12.4 years) is an internal biological hazard. In the most common biologically important form of tritiated water (THO), tritium moves through the biosphere essentially along water pathways. Knowledge of these pathways in the predictable terms of environmental conditions is required for calculating the radiological hazard to man. A tritium tracer technique with computerized data analysis was developed that effectively enables measurements of tritium oxide transpiration and soil water transport without prejudicing the local environment. This tritium tracer technique was used for studies of an arid location (Livermore, California). The correlation of the tracer results with the more conveniently measurable micrometeorological variables was studied. (C.H.)

9487 (UCRL-73546) SIGNIFICANCE OF TRITIUM RELEASES TO THE ENVIRONMENT. Koranda, J. J.; Martin, J. R.; Anspaugh, L. R. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Nov 1971. 18p. (CONF-711111-23). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

Tritium is produced naturally and was present in low concentrations in precipitation and natural bodies of water before atmospheric testing of nuclear weapons. Other sources of tritium are now present from which tritium is released to the environment. Nuclear reactor tritium production, according to recent estimates, will equal natural tritium production before the year 2000. Predicted increases of tritium in the environment will take place first on a local ecological level and then appear on a biospheric level. Tritium introduced into the environment as THO will move through ecological systems in the same manner as stable water. Tritium will enter the hydrologic cycle either via evapo-transpiration or the surface bodies of water. Data are reviewed from a number of ecological experiments conducted to determine the movement of tritium in the environment. Field-grown plants were exposed to liquid and vapor THO for periods of one-half and one hour. Tritium concentrations were determined in leaf samples collected after exposure for periods of time up to 45 days. Tritium decays rapidly in the plant species studied and exhibited a three component half-life when plants were exposed to THO vapor. The length of exposure, and sources of THO in the soil affect the half-time of tritium in the plant tissues. Data produced in ecological experiments on tritium movement were used in a theoretical consideration of acute and chronic vapor releases of tritium in an agricultural environment. An acute release of THO for one hour at a concentration of 2×10^5 pCi/meter^3 will persist in the environment long enough for transfer of tritium to man via cow's milk to occur. Plants will contain $6.66 \times MPC_w$ under these conditions but ecological dilution will reduce this to 0.36 MPC_w in milk and 0.01 MPC_w in the body water of man. Chronic release of THO vapor at a concentration of 2×10^5 pCi/meter^3 produces THO concentrations of $6.66 \times MPC_w$ in plants, $2.02 \times MPC_w$ in milk, and 0.17 MPC_w in the body water of man from the ingestion of milk. Short-lived THO vapor releases over as short a time as one hour will have some ecological and biological consequences in terms of human food chain effects, however rapid uptake and incorporation of tritium are offset by rapid losses and dilution in the ecological water compartments of the environment. (auth)

9488 EFFECTS OF ENVIRONMENTAL PARAMETERS ON THE UPTAKE OF RADIOISOTOPES IN FRESHWATER FISH. Lipke, Edward Joseph Jr. Ann Arbor, Mich.; Univ. of Michigan (1971). 130p. University Mircrofilms Order No. 71-23,807.

Thesis.

Because the fathead minnow (Pimephales promelas) is an omnivorous fish and therefore capable of reflecting many effects within the food chain, it was selected as the test organism. This study describes the effects of temperature, food source, pH, illumination, water hardness, and carrier concentration on the resultant accumulation of Cs-137 and Zn-65 in the fish. Laboratory aquaria were equipped with a flow-through system of water supply; analyses of radioactive concentrations were accomplished by γ spectrometry. Spectrum stripping, statistical summary, and curve fitting were done by computer. It was concluded that the concentration of radioactivity in the food of the fathead minnow has a direct relationship to the resultant concentration of radioactivity in the fish. Nonetheless, the contribution of activity from water cannot be overlooked. The relative importances of water and food as sources of isotope vary according to the concentration of activity in the food and must be considered separately in individual situations. Temperature has a substantial effect upon the accumulation of ^{137}Cs and ^{65}Zn in fish. In the case of ^{137}Cs, equilibrium concentrations are proportional to temperature for uptake from food and independent of temperature for uptake from water. Rate of uptake from food and rate of uptake from water are independent of temperature. The rate of isotope loss is proportional to temperature. In the case of ^{65}Zn, equilibrium concentrations are proportional to temperature for uptake from food and independent of temperature for uptake from water. Rate of uptake from food is independent of temperature; rate of uptake from water is proportional to temperature. The rate of isotope loss is independent of temperature. The relative importance of food as compared with water as a source of either isotope increases with temperature. The uptake of both isotopes is independent of illumination. Accumulation of ^{137}Cs is independent of calcium concentration and zinc concentration in water. The uptake of ^{65}Zn is inversely proportional to calcium concentration and stable zinc concentration in water. However, ^{65}Zn accumulation might become independent of carrier concentration for levels of stable zinc in excess of 100 ppB. (Diss. Abstr.)

9489 UPTAKE OF ^{90}Sr BY CALVES ON PASTURE. Korneev, N. A.; Burov, N. I.; Panchenko, I. Ya. (Inst. of Biophysics, Moscow). Sel'skokhoz. Biol.; 6: No. 2, 180-3(1971). (In Russian).

When pasturing the calves on lands with the surface contaminated with strontium-90, radioactive isotopes get into the animal during the absorption of a cumulated radioactive fallout from the soil surface or sod. Besides the usual biological soil–plant–animal chain of radioactive elements getting into the organism there is an additional course of radioisotopic introduction through the soil–animal chain. The additional amount due to the soil–animal chain doubles the extent of the isotope accumulation in calves 3 to 6 months old. (auth)

9490 ECOLOGICAL ASPECTS OF METALS. Lisk, Donald J. (Cornell Univ., Ithaca, N. Y.). N. Y. State J. Med.; 71: No. 21, 2541-55(1 Nov 1971).

A discussion is presented of the origin of metals in soils, the effects of fertilizers and pesticides on the mineral content of soils, and soil-plant relationships. The hazards of toxic metals in water and aquatic ecosystems are pointed out and the toxicological implications of mercury to fish are emphasized. A review is given of the literature on toxic effects of metals on animals and man under environmental conditions. The occurrence of ^{210}Pb and ^{210}Po in wildlife, ^{90}Sr in Alaskan caribou, and ^{137}Cs in Canadian reindeer is discussed. The hazards of metal radionuclides, such as ^{137}Cs, ^{90}Sr, ^{210}Pb, ^{210}Po, and ^{65}Zn, to man are emphasized. Beneficial effects of certain metals, such as chromium and selenium, are also discussed. (H.L.W.)

9491 SPECIES AND INDIVIDUAL PRODUCTIVITY IN PHYTOPLANKTON COMMUNITIES. Maguire, Bassett Jr.; Neill, William E. (Univ. of Texas, Austin). Ecology; 52: No. 5, 903-7(Late Summer 1971).

The relative productivity of individual cells in a mixed phytoplankton community has been determined by a new technique using ^{14}C autoradiography. These data allow the estimation of the relative contribution of each of the component species to total community production, illustrate the size-specific production of the cells of each of these species, and suggest predictions concerning future successional developments of the community. (auth)

9492 EFFECT OF STOMATAL OPENING ON THE TRANSFER OF $^{131}I_2$ FROM AIR TO GRASS. Adams, Donald R.; Voilleque, Paul G. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys.; 21: No. 6, 771-5(Dec 1971).

The effect of stomatal opening on the air-to-grass transfer of molecular iodine gas (I_2) was studied in a small environmental chamber with an airflow rate of about 1 m/sec above the grass. Measured stomatal densities and stomatal areas were used to determine the per cent of Bromegrass leaf area composed of stomatal openings (A_s). The transfer parameter $P_t(g^{-1})$ (analogous to the normalized transfer velocity) was found to be directly dependent upon stomatal opening as measured by A_s: $P_t = 2.21 \times 10^{-4} + (4.60 \times 10^{-4})A_s$. The maximum value of P_t observed was 5.43×10^{-4} g^{-1} or 2.4 times that observed for $A_s \sim 0$. This proportionality to pore area is in agreement with measured diffusion rates through perforated metal screens. It was also found that Bromegrass is far from a perfect sink for sorption of $^{131}I_2$, a fact which must be considered in the development of models of radioiodine transfer. Retention of radioiodine by contaminated foliage is dependent on the radioiodine transfer process and the implications of the current results are indicated. (auth)

9493 BEHAVIOR OF ^{137}Cs AND OTHER FALLOUT RADIONUCLIDES ON A MICHIGAN DAIRY FARM. Pelletier, Charles A. (Univ. of Michigan, Ann Arbor); Voilleque, Paul G. Health Phys.; 21: No. 6, 777-92(Dec 1971).

The behavior of the fallout radionuclides ^{137}Cs, ^{54}Mn, $^{144}Ce-Pr$, and ^{90}Sr in the milk-food chain was studied at a commercial dairy farm near Tecumseh, Michigan during 1964 and 1965, in order to develop mathematical models describing the movement of radionuclides from air to milk. Three models are presented: the first predicting the total deposition on precipitation collectors given the air concentration and rainfall rate; the second predicting the concentration in forage from air concentration, rainfall rate, and the rates at which the forage grows and is consumed by the dairy herd; the third predicting the milk concentration from the concentration in each type of feed and the rate at which each feed type is consumed by the dairy herd. The first two models were applicable to all four radionuclides but the milk model was valid only for ^{137}Cs. Milk concentrations for the other three radionuclides were treated individually. The model for deposition on precipitation collectors was developed independently and predicted weekly deposition rates to within a factor of three (95% of the time). This uncertainty was reduced as the time span for the prediction was increased. Development of the other two models was based in part on data from the Tecumseh study. The forage model fitted the weekly experimental data to within a factor of 2.2. The milk model fitted the weekly measurements of ^{137}Cs concentrations to within a factor of 1.5. The error of the latter two models also decreased as the time span for the prediction increased. (auth)

9494 RADIOISOTOPE ACCUMULATION IN FRESH WATER ORGANISMS. Piskunov, L. I. (Sverdlovsk Regional Health Epidemiological Station, USSR). Gidrobiol. Zh., 7: No. 1, 64-8 (1971). (In Russian).

Data were collected on the uptake by freshwater plants and animal organisms of the following pairs of isotopes: $^{35}S-^{137}Cs$, $^{90}Sr-^{137}Cs$, $^{106}Ru-^{144}Ce$, $^{137}Cs-^{144}Ce$, and $^{210}Pb-^{90}Sr$ for correlative purposes. The data were treated statistically and equations of regression were obtained for each pair of isotopes. (K.S.W.)

9495 UPTAKE OF DISSOLVED ^{89}Sr BY CARP. Gus'kova, V. N.; Prokof'ev, O. N.; Zasedatelev, A. A.; Il'in, B. N.; Tikhonova, A. I. (Leningrad Inst. of Radiation Hygiene). Gidrobiol. Zh.; 7: No. 1, 68-71(1971). (In Russian).

The dynamics of the uptake by the tissues of carp of ^{89}Sr from once-polluted aquarium water was investigated. To an aquarium holding 100 l of water (15 to 30 mg of minerals of natural origin/l) there were simultaneously added 30 carp and sufficient fragment radioisotopes to furnish an initial ^{89}Sr concentration of 1.4 μCi/l (from a total concentration of about 13 μCi/l). Samples of water, sand, and fish were removed for radiochemical analysis every five days, with the following results: ^{89}Sr concentration in the water decreased steadily from 1.4 to 0.81 μCi/l; in the dermal muscle tissue, steadily increased from zero to 2.6 μCi/kg; in the axial skeleton, steadily increased from zero to 34 μCi/kg. (K.S.W.)

9496 NUCLEAR WEAPONS AND ECOLOGY. Cough, Virgil L. (Assistant National Director of Civil Defense, Washington, D. C.). Environ. Contr. Saf. Manage.; 141: No. 3, 38-43 (Mar 1971).

A general discussion is presented of the following ecological aspects of nuclear weapons: the threat of nuclear attack; wartime emergency planning; characteristics of nuclear weapons; types of burst; blast effects; nuclear radiation; pattern of fallout distribution; radiation hazards; protection from fallout; and the national civil defense program. Tables are presented to show comparison of newsprint ignition radii and low blast overpressure radii; approximate ignition thresholds for several kindling fuels exposed to low air burst of nuclear weapons; and probable biological effects of radiation exposure on personnel. A diagram is given to show effects of a 20 megaton blast on the population over a 15 mile radius. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 9563, 9603, 9611, 9619, 9653, 9659, 9661, and 9662.

9497 (CALT-767-P-5-X-3) MUTATIONAL ANALYSIS OF DEVELOPMENT IN DROSOPHILA MELANOGASTER. 3-Year Comprehensive Report. Lewis, Edward B. (California Inst. of Tech., Pasadena. Div. of Biology). Aug 1971. Contract AT(04-3)-767. 7p. Dep. NTIS.

X-rays and chemical mutagens were used to analyze a cluster of bithorax genes which control the course of development of certain body segments in Drosophila melanogaster. During the 3-year period research has concentrated on inducing small chromosomal fragments or duplications containing either this gene cluster or a regulator-like mutant which appears to repress the action of one of the genes of the bithorax cluster. Results were good not only in inducing such duplications but in marking them with regions showing marked fluorescence after quinacrine staining and with easily identifiable genetic markers affecting body color or eye color. An analysis of the regulator-like mutant shows that its effects depend upon how many doses are present of the gene it is apparently specifically repressing. As a byproduct of these studies the pattern of quinacrine fluorescence in resting as well as dividing cells of certain somatic and adult tissues was also investigated. It appears that such fluorescent patterns will prove useful in many types of developmental studies in this organism in which it is desired to follow either in mosaic individuals or in tissue cultures the number of Y chromosomes or Y-marked chromosomal fragments. (auth)

9498 (CONF-710611-3) RADIATION AND CHEMICAL MUTAGENESIS AND REPAIR IN MICE. Russell, W. L. (Oak Ridge National Lab., Tenn.). [1971]. 17p. Dep. NTIS.

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971).

Effects of radiation dose, dose rate, and dose fractionation on the repair of radioinduced mutation damage in mice are reviewed. Studies on effects of dose rate on specific-locus mutation frequencies in spermatogonia gave the first evidence of the existence of repair of mutational damage in mice. Experiments showed that repair occurred at low dose rates but that the repair process was damaged or saturated at high dose rates. A comparison of the effects of lowering the dose rate on oocytes and spermatogonia showed that the mutation frequency in oocytes continued to drop with lowering dose rate, but that in spermatogonia a plateau was reached below which further reduction in dose rate gave no further reduction in mutation frequency. Results suggested that there was a greater capacity for repair in females than in males. Studies on relative frequencies of mutations at the seven loci used in the experiments showed that the pattern of relative frequencies did change when mutations in different germ-cell stages and types were compared. A review of studies on mutation frequencies in females showed that, even with high dose-rate irradiation, a great drop in mutation frequency occurred for conceptions at intervals longer than six or seven weeks after irradiation. A review of the effects of chemical mutagens on mice showed that the responses of mice were strikingly different from those of microorganisms or Drosophila. Methanesulfonates that produced chromosome aberrations in mice were not effective in inducing specific-locus mutations. The ratio of mutation frequency in spermatogonia to that in post-spermatogonial stages was extremely low compared to that observed with radiation. (H.L.W.)

9499 (IAEA-R-238-F) INDUCED MUTATIONS FOR BLAST-RESISTANCE, EARLY MATURITY, AND HIGH-YIELDING CAPACITY IN RICE. COORDINATED PROGRAMME ON THE USE OF INDUCED MUTATIONS FOR RICE IMPROVEMENT. Final Report, April 1, 1968-May 31, 1970. Tanaka, Sachihiko (International Atomic Energy Agency, Vienna (Austria)). 31 May 1970. 5p. INIS.

Out of radiation-induced mutant lines with extremely early maturity, three lines having the same productivity as, or higher productivity than, the parent variety under favorable cultivating conditions were selected on the basis of three-year tests. These lines had higher lodging resistance than the parent variety under high planting density and heavier fertilization, resulting from shorter culm length. Although these mutant lines had high yielding capacity in north-east region in Japan, they were not recommended

as commercial varieties, because of their susceptibility for blast disease derived from the parent variety. It was concluded that a variety with extremely early maturity and with high productivity can be bred with mutations, but it is not effective to use old varieties as materials for direct breeding of commercial varieties, because genetic backgrounds of old varieties are different from those of commercial varieties. (auth)

9500 CHROMOSOME-ABERRATION FREQUENCY IN CULTURED BLOOD-CELLS IN RELATION TO RADIATION DOSE OF A-BOMB SURVIVORS. Awa, Akio A.; Honda, Takeo; Sofuni, Toshio; (and others) (Hokkaido Univ., Sapporo. Dokkyo Univ., Soka, Japan). Lancet; II: No. 7730, 903-5(23 Oct 1971).

243 heavily exposed survivors of the atomic bombings of Hiroshima and Nagasaki and 213 distally exposed controls of all ages were examined cytogenetically. Using a 2-day-culture method, it was found that there was an increase in the frequency of cells with radiation-induced chromosome aberrations proportional to radiation dose. Cells with stable-type aberrations, such as translocations and pericentric inversions, predominated, although cells with dicentrics and rings were also present to a lesser degree. All these aberrations were greater in frequency in the exposed than the controls. In-vivo clones of aberrant cells were seen in 14 heavily exposed persons. The two cities differed in frequencies of stable and unstable aberrations in each dose group, but the reason for this difference is not known. (auth)

9501 MITOTIC EVENTS AND OTHER DISORDERS INDUCED IN COWPEAS, VIGNA UNGUICULATA (L.) WALP. BY IONIZING RADIATION. Ojomo, Olatunde A. (Ministry of Agriculture and Natural Resources, Ibadan, Nigeria); Chheda, H. R. Radiat. Bot.; 11: No. 5, 375-81(Oct 1971).

Studies of cytological, some morphological, and other disorders were made in the MI generation of cowpeas following exposures to x rays and thermal neutrons. Though the incidence of chromosome aberrations was very high at the first mitotic stage, seed germination was apparently unaffected, but seedling survival diminished as level of treatment increased. The frequency of cells showing chromosome disorders decreased as growth advanced the cells having been apparently eliminated by diplontic selection. These events appeared to be related to the appearance of leaf spots, alteration in the leaflet number of normally trifoliate leaves, and gross leaf distortions at early growth and their disappearance from subsequent growth. (auth)

9502 MECHANISMS OF GENES fil^+, uvr^-, AND exr^- INFLUENCE ON RADIOSENSITIVITY OF ESCHERICHIA COLI. Myasnik, M. N. (Inst. of Medical Radiology, Obninsk, USSR). Genetika; 7: No. 10, 59-70(Oct 1971). (In Russian).

Unirradiated cells of Escherichia coli B_{s-1} are characterized by a reduced survival if they are growing on nutrient salt-free agar and by increasing sensitivity to lysozyme without additional agents. Most spheroplasts of E. coli B_{s-1} produced under lysozyme treatment are quickly lysed in the presence of immune antiserum and complement while the same spheroplasts of E. coli B and E. coli B/r remain unchanged. The increasing sensitivity of E. coli B_{s-1} growth to nutrient salt-free agar and the instability of its spheroplasts are due to a defect of the cytoplasmic membrane in this strain, and the increasing sensitivity to lysozyme is indicative of a defect of a surface part of the cell membrane. The cultivation of uv- or gamma-irradiated cells of E. coli B_{s-1} on the nutrient agar with 20% sucrose results in increased survival of cells. In this case the survival of E. coli B_{s-1} after gamma-irradiation is the same as that of E. coli B. The combined action of chloramphenicol and sucrose medium on irradiated cells increases the survival of uv-irradiated E. coli B_{s-1} cells up to the level of E. coli B and after gamma-irradiation up to the level of E. coli B/r. It is assumed that the mutation in gene exr is responsible for defects in the structure of cytoplasmic membrane. UV-irradiated cells of E. coli B_{s-1} form L-colonies when they are growing on sucrose medium. Grown on nutrient agar with 20% sucrose and 10% normal bovine serum, they revert to normal macrocolonies. It is supposed that the transformation of uv-irradiated E. coli B_{s-1} cells into L-forms is due to a defect of synthesis of components in a surface part of the cell membrane as a result of the mutation of gene uvr. (auth)

9503 INDUCTION BY UV LIGHT OF MUTATIONS RESISTANT TO A HYPOXANTHINE ANALOG IN CULTURED CHINESE HAMSTER CELLS. Manuilova, E. S.; Shapiro, N. I. (Inst. of Atomic Energy, Moscow). Genetika; 7: No. 10, 46-50(Oct 1971). (In Russian).

The effect of uv-irradiation on survival and frequency of mutants resistant to a hypoxanthine analogue (6-mercaptopurine) was studied in uv-sensitive cultured Chinese hamster cells. The analysis of the dose-response curves revealed that among uv-sensitive cells, which prevailed in the population studied, there was a small fraction of comparatively resistant cells. The latter were also more resistant to the mutagenic action of uv-light. It was shown that the yield of mutations was higher when the cells were subjected to the action of the selective medium immediately after irradiation at doses of 50 and 100 erg/mm^2. In this case a linear dependence of mutation rate upon uv-dose appeared to take place. (auth)

9504 RADIATION-INDUCED HUMAN CHROMOSOME ABERRATIONS. II. HUMAN IN VITRO IRRADIATION COMPARED TO IN VITRO AND IN VIVO IRRADIATION OF MARMOSET LEUKOCYTES. Brewen, J. G.; Gengozian, N. (Oak Ridge National Lab., Tenn. Oak Ridge Associated Universities, Tenn.). Mutat. Res.; 13: No. 4, 383-91(Dec 1971).

Whole blood cultures from humans and from the New World primate, Saguinus fuscicollis, were irradiated with various doses of 250 kV x-rays. The resulting centric ring plus dicentric aberration yields were fitted to the three models, $Y = a + bD$, $Y = a + bD + cD^2$, and $Y = a + cD^2$, by least squares regression. In both instances the best fit was to the model $Y = a + bD + cD^2$, with coefficients of the one- and two-track components for human and marmoset being: $b = (0.78 \pm 0.09) \cdot 10^{-3}$, $c = (5.92 \pm 0.31) \cdot 10^{-6}$, and $b = (1.11 \pm 0.36) \cdot 10^{-3}$, $c = (7.7 \pm 1.7) \cdot 10^{-6}$, respectively. Whole-body irradiation of several marmosets was done with ^{60}Co γ-rays at a dose rate of 3.7 R/min. Blood samples were drawn immediately and 24 h after the irradiation, and the aberration yields in the circulating leukocytes were measured. The aberration yields at the two sampling times were identical. Concurrent with these studies, freshly drawn whole blood was irradiated in the same manner for the purpose of in vivo to in vitro radiosensitivity comparison. In this instance the in vitro irradiation produced aberration yields identical to those from in vivo irradiation. (auth)

9505 PATHWAYS OF ULTRAVIOLET MUTABILITY IN SACCHAROMYCES CEREVISIAE. II. THE EFFECT OF rev GENES ON RECOMBINATION. Lemontt, Jeffrey F. (Univ. of California, Berkeley). Mutat. Res.; 13: No. 4, 319-26(Dec 1971).

Recombination at both intergenic and intragenic levels has been investigated in diploid yeast strains each homozygous for one allele of three different rev loci that cause reduced uv mutability. Meiotic recombination between leu1 and trp5 and between arg4-6 and arg4-17 was found to occur at control frequencies. The frequencies of uv- and x-ray-induced mitotic recombination, measured for both the ade2-centromere and arg4-6–arg4-17 regions, increased more sharply with radiation dose in rev/rev diploids than in wild type. Since rev mutations do not cause recombination deficiency, it is suggested that mitotic recombination as measured in this study, although induced by uv damage, is not correlated with uv mutagenesis. (auth)

9506 PATHWAYS OF ULTRAVIOLET MUTABILITY IN SACCHAROMYCES CEREVISIAE. I. SOME PROPERTIES OF DOUBLE MUTANTS INVOLVING uvs9 AND rev. Lemontt, Jeffrey F. (Univ. of California, Berkeley). Mutat. Res.; 13: No. 4, 311-17(Dec 1971).

Haploid yeast strains doubly mutant for both uvs9-2 and one of three different rev loci responsible for defective uv-induced mutability were found to be significantly more uv-sensitive than a strain carrying uvs9-2 alone. The dose reduction factors (DRF) at 1% survival were 1.7 (uvs9-2 rev 1-1), 4.1 (uvs9-2 rev2-1) and 1.9 (uvs9-2 rev3-1) relative to the uvs9-2 strain. Although uvs9 strains are highly sensitive to uv mutation, uvs9 rev strains are defective in uv reversion of the arg4-17 site. All strains carrying two or three rev loci, while severely reduced in uv mutability, were found to be just as uv-sensitive as the rev3-1 strain, one which is approximately twice as sensitive (DRF = 2) as a strain carrying either rev1-1 or rev2-1. It is suggested that UVS9 controls repair of primary (initial) uv damage, REV genes act on damage unrepaired by uvS9, and rev1 and rev2 each block different parallel repair pathways that generate some common intermediate, which in turn enters the rev3 branch to produce repaired DNA containing uv-induced mutations. (auth)

9507 GENETIC CONTROL OF DARK RECOMBINATION IN YEAST. Hunnable, Elizabeth G.; Cox, Brian S. (Botany School, Oxford). Mutat. Res.; 13: No. 4, 297-309(Dec 1971).

The post-uv effects of dark holding and photoreactivating light on survival and intragenic recombination in uv-sensitive strains of yeast have been studied. The results indicate that two liquid holding dark repair pathways exist in this organism; the excision pathway which does not lead to intragenic recombination (''silent'' repair) and a dark recombination pathway which does lead to intragenic recombination. A third pathway also exists which is plating-dependent and leads to intragenic recombination via a postreplication pathway. Some of the uv-sensitive mutants iso-

lated by various workers have been characterized with respect to their responses to uv and post-uv treatments and allocated to positions on a generalized scheme for repair and intragenic recombination. (auth)

9508 RADIATION-INDUCED TRANSLOCATIONS IN INSEMINATED EGGS OF DROSOPHILA MELANOGASTER. Wuergler, F. E. (Swiss Federal Inst. of Tech., Zurich). Mutat. Res.; 13: No. 4, 353-9(Dec 1971).

The induction of reciprocal translocations by x-irradiation (500 R) of freshly laid inseminated eggs of Drosophila melanogaster was studied. In such eggs the maternal and paternal chromosome sets are exposed while they are within the same cell but in spatially separated nuclei. A constant rate of 0.3% translocations within the maternal chromosome set was found throughout the period during which the maternal genome passes from meiotic metaphase I to the pronuclear stage. During the same period the sperm head, containing the paternal chromosome set, transforms into the paternal pronucleus. At the beginning of this transformation a rate of 2.3% translocations within the paternal chromosome set was found. This rate fell, with the progression towards the pronuclear stage, to about 0.2%. From the recovery of three maternal–paternal translocations it was estimated that the maximal rejoining time of chromosome breaks was on the order of 10 min. (auth)

9509 EFFECT OF FRACTIONATION TREATMENT WITH GAMMA-RAYS ON THE MUTATION FREQUENCY IN MAIZE. Fujii, Taro (National Inst. of Genetics, Misima, Japan). Jap. J. Genet.; 46: No. 4, 243-51(Aug 1971).

Pollen of Zea mays plants with mutations for a bronze-colored endosperm were exposed to single and fractionated doses of gamma radiation. Total doses of up to 3000 R were used. The irradiated pollen was then used for crossing experiments with recessive plants. The seeds developing from these crosses contained endosperms that were entirely bronze-colored (whole mutations) or partially bronze-colored (partial mutations). A linear dose relationship with partial and whole mutations was observed. Dose fractionation did not influence the frequency of partial mutations, but the frequency of whole mutations was decreased by an interval of 120 minutes or less. No temperature effect was found. (H.L.W.)

9510 RADIATION-INDUCED TRANSLOCATIONS IN MOUSE SPERMATOGONIA. Muramatsu, Susumu; Nakamura, Wataru; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). Jap. J. Genet.; 46: No. 4, 281-3(Aug 1971).

Male mice were exposed to whole-body x radiation in doses of 50 to 700 R. Ten weeks later preparations of meiotic cells were made and two hundred meiotic figures were analyzed for each mouse. A table is presented to show frequency of presumptive translocations in primary spermatocytes after various x-ray doses. The percentages of abnormal cells increased linearly with the exposure dose from 1.2% after 50 R to 14.1% after 700 R. An equation is presented to show the relationship between x-ray dose and frequency of translocation per cell. (H.L.W.)

9511 STATISTICAL ANALYSIS OF IRRADIATION DAMAGED PLANT CHROMOSOMES IN RELATION TO THE VARIABILITY OF EXPERIMENTAL DATA. Ganassi, E. E.; Lyamin, E. A.; Aptikaeva, G. F.; Eidus, L. Kh. (Inst. of Biological physics, Puschino-on-Oka, USSR). Genetika; 7: No. 12, 30-8(Dec 1971). (In Russian).

Distribution of chromosome rearrangements in root cells of Vicia faba seedlings following doses up to 100 rad obeyed Poisson's law, while the distribution in other plants did not obey this law. Methods of calculating the standard deviation were experimentally examined and a method of reducing the time needed for analysis of radiation damage using the criterion of chromosome rearrangements is suggested. (auth)

9512 GAMMA-RAY INDUCED MUTATIONS IN JUTE (C. OLITORIUS L. AND C. CAPSULARIS L.). Neogy, A. K. (Univ. of Calcutta). Farm J. (Calcutta); 10: No. 1, 47-51 (1968).

Soaked seeds of two strains viz., JRO-632 and JRC 212 of Corchorus olitorious and C. capsularis resp., were irradiated with gamma rays of dosages 10,000 R to 40,000 R. The resulting mutants showed various types of leaf, stem, flower, fruit and pigmentation abnormalities. Four types of mutants were recognized and described. (BK) (Indian Sci. Abstr.)

9513 GAMMA-RADIOINDUCED MUTATIONS IN SWEET POTATO. Harn, Chang Yawl; Kim, Young Sang. Korean J. Hort. Sci.; 6: 29-33(1969).

In order to obtain high starch and good yield mutant lines in sweet potato, sprouts of a sweet potato variety, Suwon No. 147, were irradiated with 1, 2, 4, 8 and 16kR of gamma rays. The various changes in shape and skin color of tuberous root were observed in irradiated progenies, R, R. Variations in the T/R value of and weight of tuberous roots showed a pronounced decrease; however, there was an increase in the number of tuberous roots per plant. A wide range of variations for the characters studied was found in this study. The results indicate that there is a possibility of developing useful mutant lines which possess good yield capacity, high starch content, and better storing ability. (Korean Sci. Abstr.)

9514 INDUCTION OF MUTATIONS BY THE INDIRECT EFFECT OF IONIZING RADIATION IN OOCYTES OF DROSOPHILA MELANOGASTER. Ondrej, M. (Inst. of Experimental Botany, Prague). Folia Biol. (Prague); 17: No. 5, 299-303 (1971).

Ionizing radiation was shown to induce recessive lethals in Drosophila melanogaster not only in irradiated gametes, but also in the chromosomes of non-irradiated oocytes following their fertilization by irradiated spermatozoa. In the latter case, the frequency of recessive lethals was under the given experimental conditions only 3.6 times lower than in oocytes irradiated directly. High frequencies of detachments of attached XX chromosomes were found in irradiated oocytes and of large chromosomal fragments in irradiated spermatozoa. None of these aberrations were induced indirectly, through fusion with the other irradiated gamete. On the basis of these data genetic damage to the gametes of drosophila appears to be—according to their origin—of two basic types: arising through the direct effect of irradiation and through the effect of short-lived radiochemical products: in addition to recessive lethals, this type of damage consists also of large chromosomal rearrangements; arising through long-lived radiochemical products; these do not include large chromosomal rearrangements, but only recessive lethals. (auth)

9515 CHANGES IN THE VARIABILITY OF QUANTITATIVE CHARACTERS IN M_2 INDUCED IN EINKORN WHEAT BY N-NITROSO-N-METHYLUREA AND X-RAYS. Vagera, J. (Palacky Univ., Olomouc, Czech.). Biol. Plant. (Prague); 13: No. 5-6, 279-89(1971).

Changes in the variability of quantitative characters (number of fertile stems, length of the stem and of the spike, number of spikelets in the spike, number of seeds in the spike and in the spikelet) in M_2 induced with 0.1 mM, 0.2 mM and 0.3 mM N-nitroso-N-methyl-urea (MNH) and with 5,000 R and 10,000 R of x-rays in Triticum monococcum L. var. sofianum Körn. were evaluated. The mean of the populations remained practically unchanged by the mutagens whereas the variability increased considerably with increasing concentration or dose. Changes in the variability were more pronounced in the values for the first stem than in the values for the first three stems. When changes in the population mean were found (with some of the most elevated concentrations and doses), these changes were shown to be mostly due to a repetition of the cultivation, whereas the changes in the variability were mostly due to the action of the mutagens. In all experimental populations, mutations in quantitative characters were successfully induced. (auth)

9516 RADIATION INDUCED MUTATIONS IN BRASSICA CAMPESTRIS L. EFFECT OF GAMMA IRRADIATIONS UPON SEEDS PER POD AND SEED INDEX. Abidi, Zafar Husain; Haq, Muhammad Ikramul (College of Agriculture, Tandojam, Pakistan). Sci. Ind. (Karachi); 8: No. 2, 156-60(Apr 1971).

Seeds of three cultivars of brown mustard, Brassica campestris, were irradiated with doses of 75, 100, 125, and 175 kR of ^{60}Co γ. The M_1 generations were grown under field conditions and compared with their respective controls. It was concluded that the number of seeds per pod was reduced but the seed weight was increased through irradiation. One variety, S-2, was found to offer better promise for increasing the potential of variability for the character of seeds per pod. It was also observed that the varieties S-2 and S-4 displayed a positive response to γ irradiation treatment for seed index, and this could be exploited for the evolution of better varieties. (auth)

9517 WHOLE-BODY IRRADIATION AND HUMAN CHROMOSOMES. II. CYTOGENETIC STUDIES OF THE CULTURED BONE MARROW CELLS SEVEN YEARS AFTER TOTAL BODY IRRADIATION. Goh, Kong-oo (Oak Ridge Associated Universities, Tenn.). Amer. J. Med. Sci.; 262: No. 1, 43-9(Jul 1971).

Chromosomal breaks and cells with abnormal chromosomes were found in the cultures of bone marrow obtained from six patients who had been exposed to total body irradiation seven years previously. The frequencies of chromosomal breaks and the abnormal cells are higher than the normals. However, the frequencies of these abnormalities are similar to those found in these patients' cultured peripheral leukocytes reported previ-

ously. Fewer mitoses were seen in their bone marrow cultures when PHA was not added. Different stem-cell lines with different marker chromosomes were found in these patients, specifically a smaller G and an abnormally large acrocentric chromosome. Stem-cell lines with these abnormal morphologic chromosomes have been seen in patients with leukemia or cancer, but none of the present patients had these diseases. Thus, it seems important to determine why cytologically detectable abnormal stem-cell lines develop into leukemia or cancer in some people but not in others. (auth)

9518 SELECTION OF ASPERGILLUS ORYZAE MUTANTS, ACTIVE PRODUCERS OF ACID PROTEINASE. Zueva, R. V.; Konovalov, S. A. Mikrobiologiya; 40: No. 1, 83-7(Jan-Feb 1971). (In Russian).

Mutants of Aspergillus oryzae producing acid proteinase were selected after the action of ethylene imine (EI) and uv radiation. Three states of selection yielded 1061 variants; the mutant A. oryzae 251-90 was selected among these variants with an activity of acid proteinase 4 to 5 times higher than that of the parent strain. The most active mutants were obtained after the combined effect of EI at a concentration 1 : 2000 (30 min) and uv at a dose $25 \cdot 10^3$ erg/mm^2. Acid proteinase of A. oryzae 251-90 was found to be active at pH 3.5 to 4.5. (auth)

9519 REARRANGEMENTS BETWEEN GERM-LINE LIMITED AND SOMATIC CHROMOSOMES IN SMITTIA PATHENOGENETICA (CHIRONOMIDAE, DIPTERA). Bauer, Hans (Max-Planck-Institut fuer Zellbiologie, Tuebingen, Ger.). Chromosoma; 32: 1-10(2 Dec 1970).

Among more than 700 chromosome rearrangements induced by x-rays in oocytes of newly hatched females of Smittia parthenogenetica two cases of insertion of heterochromatin into an S chromosome have been obtained. As the S chromosomes do not contain such heterochromatic sections, the insertions must be derived from K chromosomes. Whether all K chromosomes are completely heterochromatic or whether all or some contain euchromatic sections remains open, but for the two latter possibilities no proof has been obtained. Euchromatic insertions or translocations with a banding pattern non-homologous with S chromosome sections have not been observed with certainty. Homologous duplications could all be interpreted as being derived from S chromosomes. From the K chromosome cycle it can be inferred that the K complement consists of more or less identical elements and that genetic isolation has led to their heterochromatinization. (auth)

9520 CYTOGENETIC EFFECTS OF LONG-TERM IRRADIATION ON NATURAL PLANT POPULATIONS. Cherezhanova, L. V.; Aleksakhin, R. M. (Inst. of General Genetics, Moscow. Lab. of Forest Science, Moscow). Zh. Obshch. Biol.; 32: No. 4, 494-500(Jul-Aug 1971). (In Russian).

The radiosensitivity of the natural Vicia cracca L. and Agrimonia eupatoria L. populations which were grown during several years in the environment with an increased level of ^{90}Sr was studied. In order to evaluate the changes in radiosensitivity of plant populations, their seeds and shoots were subjected to additional ("provocative") γ-irradiation. As a control, the seeds of plants which were grown in the environment with the natural background of radiation were used. Germination of additionally irradiated and unirradiated V. cracca seeds from the region with an increased level of radiation was higher than from the control areas. Germination of A. eupatoria seeds subjected to additional irradiation was higher from the region with an increased level of radiation. The number of chromosome aberrations in shoots of V. cracca and meristems of leaves and roots of A. eupatoria after additional γ-irradiation was less in the population which was grown under the influence of an increased level of radiation. The differences in the cytogenetic effect of additional γ-irradiation can be considered as an increase of radioresistance of herbaceous plants which were grown in the presence of an increased level of ^{90}Sr. An increase of radioresistance of plants under the influence of increased level of radiation was accompanied by intensification of meristematic activity which provided a higher rate of cell selection. (auth)

Health Physics and Safety

9521 SECOND NATIONAL RADIOLOGICAL SYMPOSIUM, HELD IN JACHYMOV, CZECHOSLOVAKIA, APRIL 20-24, 1970. Zahalka, J. (ed.). Radioisotopy; 11: No. 4, 453-715(1970). (In Czech). (CONF-700448).

Twenty articles are included; separate abstracts were prepared for 19. The remaining article contains only an abstract of the paper on auxiliary determinations for the dose calculation from ^{226}Ra incorporated in mouse bone. (P.C.H.)

For abstracts of individual papers see: 8678, 8750, 9269, 9346-9348, 9395-9398, 9413, 9536-9539, and 9552-9555.

Radioactive Contamination and Decontamination

Refer also to abstracts 9010, 9285, 9461, 9481, 9486, 9487, 9489, 9520, and 9572.

9522 (CEA-N-1454) USE OF WATER-GLYCOL MIXTURES IN BUBBLERS FOR TRAPPING TRITIATED WATER VAPOR. Bouin, Roger; Begault, Jean-Claude; Bertel, Evelyne (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1971. 17p. (In French). Dep. NTIS (U. S. Sales Only).

It is shown that for a sampling rate of 1.5 litres per minute, a height of 7 cm of liquid, and a weight of 100 grams, the vapor pressure of the air leaving the bubbler is equal to the theoretical saturation vapor pressure of the solution. The variations in the weight of water, the relative humidity of the air leaving the bubbler, and the apparent trapping efficiency for the tritiated water vapor, were calculated as a function of time for various water glycol mixtures at temperatures between 0 deg and 30 deg C, and relative atmospheric humidities between 30 and 100 percent. (France)

9523 (KFK-1481) RADIATION DOSE IN THE NEIGHBORHOOD OF THE KARLSRUHE NUCLEAR RESEARCH CENTER ESTIMATED FOR THE YEAR 1971. Comper, W.; Huebschmann, W. (Kernforschungszentrum, Karlsruhe (West Germany)). Sep 1971. 17p. (In German). Dep. NTIS (U. S. Sales Only).

The radiation doses at the Karlsruhe Nuclear Research Center and its environment resulting from the radioactive emissions into the atmosphere are calculated annually. The emissions of the 15 radioisotopes in the area of the research center during 1971 are listed. The main contributors are the research reactor FR-2 (emission of ^{41}Ar) and the reprocessing plant WAK (emission of ^{85}Kr). As a consequence, outer γ and β radiations make up most of the total radiation dose. These two types of radiation are represented as isodose charts in an area of up to 10 km radius around the research center. The β dose is calculated by superposition of the three main sources of emission (WAK, FR-2, and KNK). Besides, the radiation doses caused by inhalation of tritium and radioisotopes of iodine and plutonium are indicated for some locations in the center and for the surrounding villages. In all the villages the calculated doses remain far below the permissible limits. In calculating the β doses it turned out that superposition of the emissions from the WAK, FR-2, and KNK stacks did not result in new or much higher peaks. Instead, the location of the peaks was governed by the strongest emitter, WAK, and the maximum doses were increased by the other emissions only slightly (about 10%). This is a consequence of the favorable stack position with respect to the main wind direction and of the different stack heights. (auth)

9524 (LF-tr-61) EXPERIMENTAL CONTAMINATIONS BY SOLUTIONS OF AMERICIUM AND THEIR TREATMENT. Nenot, J. C.; Morin, M.; Lafuma, J. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Health Phys.; 20: 383-91(1971). 15p. Dep. NTIS.

Contamination of the body by americium was studied from several points of view: solubility of the salt used in the body, i.e., nitrate and sulfate; mode of contamination, i.e., by intravenous or intramuscular injection or inhalation; and elimination after treatment with DTPA, given either intramuscularly or by aerosol. The two salts have the same distribution of the absorbed fraction in bone, liver, kidneys, and other organs, but the migration speed of the sulfate from muscle or lung is greater. Even when administrated 24 hr after contamination and then repeated once a week, DTPA is very effective in increasing elimination both from the body and from the site of contamination. After 3 months of treatment with DTPA, muscle and lung contamination was decreased by a factor of 3.3 or 7.3 respectively and the skeletal contamination decreased by a factor of 4 or 8. In any case of contamination, the best mode of administration of DTPA is by injection. For lung contamination, administration by aerosol gives good results, but is less effective in decontaminating the bone. (auth)

9525 (SZS-9/71) RESULTS OF THE SUPERVISION OF THE DIETARY CONTAMINATION FROM ^{90}Sr AND ^{137}Cs IN THE GERMAN DEMOCRATIC REPUBLIC, 1962 TO 1969. Schulze-Wollgast, U. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr 1971. 30p. (In German). Dep. NTIS (U. S. Sales Only).

The contamination of foodstuffs with ^{90}Sr and ^{137}Cs slowly decreased in the German Democratic Republic from 1962 through 1969. The maximum contamination of milk with ^{90}Sr was found in 1963. In total diet the highest concentrations of ^{90}Sr were observed in 1963 and 1964. In 1969 the ^{90}Sr intake was 4% and the ^{137}Cs intake was 1% of the annual maximum permissible intake (AMPI), whereas in 1963 and 1964 the ^{90}Sr intake attained nearly 10% of the AMPI. (auth)

9526 AUTORADIOGRAPHIC ANALYSIS OF PLUTONIUM CONTAMINATION ON PIG SKIN. 2. CHANGE WITH CONTAMINATING TIME OF THE STATE OF PLUTONIUM ON THE SKIN, AND ITS STATE AFTER DECONTAMINATION. Tashiro, Shingo (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 5: No. 4, 187-93(Dec 1970). (In Japanese).

The purpose of the present investigation was to extend the study on plutonium skin contamination and decontamination that was previously reported. In this study, the preparation of the contaminated samples for autoradiography was carried out by the frozen-dried method and autoradiography was done using the dipping method. Dispersed and aggregated plutonium was observed on the pig skin as contamination forms. The ratio of the aggregated to the total contamination increased with contaminating time. The residual contamination on the samples that were decontaminated by synthetic detergent involved almost all aggregated plutonium, while by EDTA or sodium hypochlorite decontamination, the reverse happened. Percutaneous absorption through intact skin was not found by shorter time contamination but it was observed through a broken stratum corneum by 60 min after contamination. (auth) (Japan)

9527 EXPERIMENTAL STUDY OF RADIOACTIVE CONTAMINATION BY AEROSOLS. Colome, J.; Saroul, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 59-67(Apr 1971). (In French).

Radiological risks often arise from the dispersion of radioactive aerosols in the atmosphere. The methods used to sample such aerosols and subsequently determine the particle size spectrum, are presented; impactor, filtration through microporous membranes, electrostatic precipitators. Examinations can be made using optical or electron microscopy. Aerosols produced in a vessel containing a solution in which a critical excursion takes place, were examined. Powdered Na fires in a 400 litre vessel led to Na oxide aerosols, 85 to 90 per cent settling at the base of the vessel and 10 to 15 per cent diffusing onto the walls. Experiments on Na fires in ventilated vessels are envisaged. (France)

9528 THERAPEUTIC PULMONARY WASHING OF PLUTONIUM OXIDE CONTAMINATIONS IN THE LUNG. Kunzle Lutz, M. (CEA de Bruyeres-le-Chatel, Montrouge, France); Metivier, H.; Nolibe, D.; (and others). Poumon Coeur; 26: No. 9, 1029-38(1970). (In French).

Monkeys were contaminated by breathing in an atmosphere loaded with particles of plutonium oxide. The animals were then given 1, 3, or 5 washings of the lower lobe, each wash consisting of 5 or 10 repeated irrigations. The results obtained show that no more than 6 irrigations are necessary during a washing session, that the washing is most efficient when it takes place during the first days following contamination, and that repeated washing sessions are necessary. (France)

9529 EXPERIENCE WITH THE USE OF A FILM-PRODUCING DECONTAMINATION AGENT AND A DECONTAMINATION PASTE. Unger, H. Isotopenpraxis; 7: No. 5, 189-92(May 1971). (In German).

Surfaces contaminated with fission products were treated with film-producing decontamination agents. In approximately 70% of the practical samples, more than 90% of the radioactivity could be removed with the film. The method was effective on surfaces of steel, glass, polyvinylchloride, polyethylene, ceramics, and lacquer. Also described is a contamination paste consisting of a surface-active agent, a complexing agent, kaolin or similar substances, and carboxylmethylcellulose. Without irritating the skin, the paste was effective even in cases where soap and water were unable to remove the radioactivity. The paste also removed practically completely α-contamination from metal surfaces, electrical equipment, various plastics, and lacquered wood. In contrast to water, the paste could be applied to sharply localized areas of contamination. (H.B.G.)

9530 SOME FUNDAMENTAL ASPECTS IN THE ESTIMATION OF NUCLEAR DAMAGE. Santos, Agustin Alonso (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 15: No. 70, 113-18(Mar-Apr 1971). (In Spanish).

The concept of nuclear damage is developed. The Rem as measurement unit of such damage is introduced and some experiments to estimate the damage are discussed. Such expression covers the loss of shielding and radiocontamination of the containment vessel, the ground, inhaled air, and drinking water. Some fundamental aspects of the behavior of radiocontaminants in the atmosphere and in water currents are also considered. (tr-auth)

9531 ANALYSIS OF A CASE OF INTERNAL CONTAMINATION WITH ^{242}Cm. Vaane, J. P.; De Ras, E. M. M. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Health Phys.; 21: No. 6, 821-6(Dec 1971).

During the preparation of targets for the mass spectrometer, some ^{242}Cm escaped from the preparation box resulting in contamination of the laboratory air and subsequent ingestion of radioactivity by a technician. Nose wipe tests were taken immediately after the incident and fecal and urine samples during the following week. Air sampling filters located in three places in the laboratory were changed immediately and then at regular intervals. The size distribution of the particles was calculated from autoradiographs made from the filter samples. From the results of these analyses the quantity ingested in the respiratory tract was determined using the ICRP lung model as a guide. The distribution of the ingested material in the body organs was then estimated from the data in Publication 2 (1959) of the ICRP. Although the quantities involved predicted an internal contamination far below the maximum permissible values, this detailed analysis was carried out as an opportunity for testing the lung model in the case of curium inhalation. Interpretation and comparison of air filter sampling data with results of nose wipe and fecal tests suggested that the ICRP long model may serve as a useful guide to estimate the approximate level of an internal contamination after inhalation exposure to ^{242}Cm. (auth)

9532 RADIONUCLIDES AND SELECTED TRACE ELEMENTS IN MARINE PROTEIN CONCENTRATES. Beasley, T. M.; Jokela, T. A.; Eagle, R. J. (Univ. of Washington, Seattle). Health Phys.; 21: No. 6, 815-20(Dec 1971).

The concentrations of various trace elements and radionuclides were measured in marine protein concentrates prepared from surface feeding fishes. As with concentrates prepared from benthic fishes, the ^{210}Pb–^{210}Po pair were the most significant radionuclides present. Concentrations of stable Pb, Co, and Ag in certain concentrates were sufficiently high to contribute substantially to estimated current intakes of these elements. (auth)

9533 PREDICTION MODELS FOR ^{90}Sr IN SHED DECIDUOUS TEETH AND INFANT BONE. Aarkrog, A. (Danish Atomic Energy Commission Research Establishment, Riso). Health Phys.; 21: No. 6, 803-9(Dec 1971).

Shed deciduous teeth were collected in 1966 to 1969 in Denmark, the Faroes, and Greenland from children born in the period 1953 to 1963. 235 samples of crowns were analyzed for ^{90}Sr. The ^{90}Sr levels in deciduous tooth crowns were related to the fallout rate and the accumulated fallout. The tooth levels in children born in 1950 to 1962 could be described with the same equation as the ^{90}Sr bone levels in 1-yr-old infants born in 1962 to 1968. The prediction models for ^{90}Sr in teeth and bones showed that for given amount of fallout the Faroese levels became nearly twice as high as the Danish. The maximum teeth and bone levels were found in children born in 1963, where the Faroese level was estimated from the prediction model to be 24 pCi ^{90}Sr/g Ca. (auth)

9534 RELATION BETWEEN THE RADIOCESIUM CONTAMINATION OF THE MEAT AND MILK FROM COWS. Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France); Savy, C.; Lehr, J.; Kirchmann, R. Health Phys.; 21: No. 6, 793-802(Dec 1971). (In French).

Experiments were made to study the trend of the contamination by radiocesium of milk and meat of cows: under conditions of a single contamination of the pasture and under conditions of a continuous ingestion corresponding to the case of a constant contamination of the pasture. (auth)

9535 TEETH AS INDICATORS FOR THE CONTAMINATION OF THE BIOSPHERE WITH ^{90}Sr. Topic, B.; Custovic, F. Stomatol. Glas. Srb.; 17: 285-91(Aug-Oct 1970). (In Slovenian).

Radioactive strontium in biosphere has its origin in nuclear explosions. In the radioactive fallout ^{90}Sr and ^{89}Sr could be found. ^{90}Sr in human metabolic processes follows the destiny of calcium and is deposited in bones and teeth. The drinking water contains different concentrations of ^{90}Sr. In subterranean waters its concentration is very low, but in rain-water it could be found in higher concentration. In order to determine ^{90}Sr absorption by human teeth from the water supply, the authors examined a region of Yugoslavia two groups of school-children born in the period 1954–1961, one group consuming running water, and the other consuming rain-water from cisterns. After a thorough survey, the first permanent molars indicated for extraction have been taken out. An analysis of ^{90}Sr content in the roots of these teeth was done, separately for each group of children. This study has shown that the content of ^{90}Sr in teeth in the group of children consuming rain-water is significantly higher than in the other group. (auth)

9536 ESTIMATION OF POPULATION EXPOSURE DOSES IN NUCLEAR FACILITIES ACCIDENTS. Behounek, Frantisek. Radioisotopy; 11: No. 4, 537-57(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

A critical analysis is given of the possible sources of population exposures in nuclear facilities accidents. Special attention is paid to the transport in the atmosphere of radioactive gases and very fine aerosols. Criteria are suggested for the estimation of exposure doses. (auth)

9537 RADIATION SAFETY OF NUCLEAR REACTORS. Kopec, J.; Benes, J. Radioisotopy; 11: No. 4, 559-77(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

A survey of the development of radiation safety in CSSR is given. Some processes and phenomena accompanying reactor accidents involving the release of fission products and their possible effects are reviewed. The probable time course of events during reactor accidents, fission product release, activity retention on protective barriers, dispersion in the environment, and their consequences for contamination of the environment are considered. (auth)

9538 OCCUPATIONAL ACCIDENTS WITH RADIOACTIVE MATERIALS AT THE INSTITUTE FOR RESEARCH, PRODUCTION, AND USE OF RADIOISOTOPES. Madera, V. Radioisotopy; 11: No. 4, 579-88(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

A brief review is given on the problems of some accidents resulting in the contamination of surfaces with radioactive materials. Procedures used for decontamination are described. Precautions for preventing contamination and methods for the containment of contamination are included. (auth)

9539 INFLUENCE OF THE SECONDARY EFFECT ON THE CONTENTS OF ^{137}Cs IN THE ENVIRONMENT. Abel, E.; Mayer, J.; Durcek, K. Radioisotopy; 11: No. 4, 589-97(1970). (In Slovak).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The results of monitoring ^{137}Cs in the environment of various areas in Slovakia during 1965 showed remarkable differences in the content of ^{137}Cs in soil, grasses, and milk samples from the lowlands and those from the highlands. The values of ^{137}Cs in soil are about 1600 pCi/kg in the lowlands but near the peaks of the Roháče mountains and the High and the Low Tatras values of about 2180 pCi/kg were found. In pasture grasses from the highlands the content of ^{137}Cs was about 70 pCi/g ashes and in the vegetation of Roháče and the High and Low Tatras about 85 pCi/g. Cesium-137 content of an average of 50 pCi/g ashes was found in grasses of the lowlands. The mean value of ^{137}Cs in cow milk from the lowlands was 180 pCi/l, but from the highlands 260 pCi/l. The results indicate the dependence of the content on ^{137}Cs in the environment on geographical and meteorological influence. (auth)

Dosimetry and Monitoring

Refer also to abstracts 9262, 9298, 9299, 9301, 9311, 9320, 9326, 9385, 9643, 9651, 9670, and 10901.

9540 (BNWL-1183-10) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, July 5–October 3, 1971. Brodzinski, R. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Oct 1971. Contract AT(45-1)-1830. 15p. Dep. NTIS.

The urine specimens collected pre- and postflight from the Apollo 15 mission were analyzed for their radionuclide content. Cosmic radiation dose estimates of 695 and 660 mR are calculated from the observed ^{22}Na and ^{24}Na concentrations, respectively. The concentrations of ^{22}Na, ^{24}Na, ^{40}K, ^{42}K, ^{51}Cr, ^{59}Fe, and ^{137}Cs are given. The potassium excretion patterns of high postflight and low preflight levels established for previous missions appears to be reversed for this mission. The concentrations of 23 major, minor, and trace elements in the fecal samples from the Apollo 14 astronauts are reported. Most elemental excretion rates are comparable to rates reported for earlier missions. The major exception is potassium where loss rates are the lowest ever observed. This coincides with the anomalously low excretion of potassium in postflight urine specimens. Apparent mass balance of calcium and iron continues as in the Apollo 12 and 13 missions. Analysis of ^{210}Po in exposed Apollo 11 and 12 solar wind composition experiment foils and in blank foils of the same material yields a net equilibrium activity of $(2.29 \pm 0.34) \cdot 10^{-4}$ d/m/cm^2 of ^{210}Pb in the Apollo 12 foil. This is equivalent to an equilibrium lunar surface activity of $(3.94 \pm 0.58) \cdot 10^{-2}$ d cm^{-2} sec^{-1}. (auth)

9541 (LBL-379) ABSORBED DOSE: AN UNFORTUNATE "RED HERRING" IN RADIATION PROTECTION. Rindi, Alessandro; Thomas, Ralph H. (California Univ., Berkeley. Lawrence Berkeley Lab.). 25 Oct 1971. Contract W-7405-eng-48. 27p. (CONF-711119-5). Dep. NTIS.

From sixth annual topical symposium on radiation protection standards; Richland, Wash. (2 Nov 1971).

Man's uses of ionizing radiations are increasing rapidly, and larger numbers of people are being exposed to high linear energy transfer (LET) radiations. These radiations present interesting problems of dosimetry which are discussed in the light of experience at high energy accelerators. It is suggested that two aspects of our present scale for numerical expression in radiation protection need clarification. Firstly, the physical dimensions of dose equivalent (DE) should be defined and secondly, the precision with which DE estimates are to be made should be stated. The practical evaluation of DE in mixed radiation fields is discussed and it is suggested that this quantity is better obtained via measurements of particle flux density and energy spectra than by LET spectrometry. The advantages of the former technique over the latter are discussed briefly. (auth)

9542 (NP-19051) EXPERIMENTS ON THE INTERACTION OF IONIZING RADIATION AND TISSUES IN DIAGNOSTICS, THERAPY AND PROTECTION. Rytilae, Aaro (University Central Hospital, Helsinki (Finland). Radiotherapy Clinic). 1971. 26p. Dep. NTIS (U. S. Sales Only).

Brief summaries are presented of eight publications that discuss: dose distribution during electron beam therapy; scintigraphic studies of the prostate gland and placenta localization; the radiation dose to radiologists during various diagnostic radiographic studies; the effects of electrons on mitotic activity in normal and neoplastic tissues of rats; and methods for the reduction of the radiation dose to medical personnel during the insertion of radium applicators in patients. (C.H.)

9543 (ORNL-TM-3548) LONG-TERM HAZARD OF RADIOACTIVE WASTES PRODUCED BY THE ENRICHED URANIUM, Pu-^{238}U, AND ^{233}U-Th FUEL CYCLES. Bell, M. J.; Dillon, R. S. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 23p. Dep. NTIS.

An evaluation was made of the long-term hazards of high-level and alpha radioactive wastes generated by irradiation of three fuels representative of those that will be used to generate electrical power in the next several decades. In this evaluation, the composition and radioactivity of the wastes generated by typical LWR, LMFBR, and molten-salt breeder reactors utilizing enriched uranium, Pu-^{238}U, and ^{233}U-Th fuel cycles, respectively, have been computed for times up to 30 million years after discharge. The volumes of water necessary to dilute the various types of high-level waste to the radiation concentration guides (RCG) for ingestion in unrestricted areas were computed as a function of age of the waste. It was found that the volumes required to dilute the three types of waste were similar when evaluated at the same age and exposure. The volume of water necessary to dilute any of the three wastes aged 1000 yrs and the associated salt in the proposed Federal Repository to the RCG for unrestricted uses is less than that required to dilute the same amount of uranium ore tailings to the RCG. The high-level waste deposited in the Federal Repository will result in an alpha activity of less than 10 μCi/kg at 10,000 yrs after burial when averaged over the total mass of the Repository. The hazard of a number of types of waste contaminated to 10 μCi/kg (the upper limit assumed for surface burial) of initial parent alpha activity was also calculated as a function of time, and the time of maximum relative hazard was determined. Transuranium or alpha wastes contaminated to this level will present a maximum ingestion hazard similar to naturally occurring uranium ores. (auth)

9544 IN-PHANTOM DOSIMETRY OF ^{238}Pu CIRCULATORY SUPPORT HEAT SOURCES. Cross, F. T.; Sheppard, J. C. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 13: No. 1, 83-94(Jan 1972). (BNWL-SA-3905).

The dose rates from an implanted ^{238}Pu heat source were measured and calculated. The source material was medical grade plutonium of nominal 30 W strength. The tissue-equivalent phantoms were both a large homogeneous right-circular cylinder and a man-simulating Remab phantom. Calculated dose rates agreed to within 20 percent with measured values except for positions very close to the source. The reasons for discrepancies greater than this are thought mainly to arise from the uncertainties in the photon emission rate and the use of dosimeters too large for neutron measurements close to the source. In general, the agreement of the measured and calculated values is good, at least in the regions where the photons and neutrons make their greatest dose contribution for a source enclosed in a circulatory support system. It is concluded that an artificial heart device incorporating a medical grade plutonium heat source is probably acceptable to the recipient from a radiation dose standpoint independent of its acceptability as a prosthetic device. (auth)

9545 ROLE OF WHOLE-BODY COUNTING IN ROUTINE MONITORING PROGRAM. Yoshizawa, Yasuo; Naito, Kaoru;

Anzai, Ikuro; Imahori, Akira (Tokyo Univ.). Hoken Butsuri; 5: No. 4, 205-9(Dec 1970). (In Japanese).

The principle of whole-body counting is widely applied to various fields of science. Much emphasis was placed on the detection of a very small quantity of radioactivity, thus strenuous efforts were made to improve sensitivity and energy resolution of equipment. In order to accomplish the purpose of radiation protection effectively, however, the following three points become more important: clarifying the role of whole-body counting in the radiation protection service; giving the whole-body counter the function as an individual monitor of internal exposure; and utilizing the whole-body counter more easily and frequently, feeding the result back to the radiation protection service rapidly. The present paper gives some basis for the argument that a simplified whole-body counter can meet these requirements satisfactorily, and that effective and economical radiation protection can readily be accomplished by this simplification. The basic properties required of the simplified whole-body counter for the monitoring purpose are considered in view of efficiency of detectors, its mechanism, and the way of utilizing it in the routine monitoring program. As an example, the paper describes the outline of the simplified whole-body counter intended to be installed in a certain nuclear power station. (Japan)

9546 MEASUREMENT OF ^{90}Sr AND ^{137}Cs IN MILK. Liu, Wu-schyong (Atomic Energy Council, Taipei, Taiwan); Chu, Tieh-chi; Weng, Pao-shan. Hoken Butsuri; 5: No. 4, 195-8 (Dec 1970).

Samples of liquid milk from Hsinchu, fifteen varieties of powdered milk from Taiwan, and imported powdered milk from Holland, Denmark, USA, Japan, and Australia were measured for their ^{90}Sr and ^{137}Cs contents. The average ^{90}Sr and ^{137}Cs content of Hsinchu milk is 2.5 pCi/gCa and 6.4 pCi/gK respectively between October 1968 and July 1969. The increase in the average level of ^{90}Sr by a factor of 1.4 as compared with that in 1964 is attributed to the nuclear weapon tests at Lop Nor. The ^{90}Sr and ^{137}Cs contents in the Australian powdered milk are found to be about the same and in the North European and American powdered milk about two or three times that in Taiwan powdered milk. (auth) (Japan)

9547 SOME RECENT METHODS FOR NEUTRON PERSONNEL MONITORING. Nikodemova, Denisa (Inst. of Industrial Hygiene and Occupational Medicine, Bratislava). Jad. Energ.: 17: No. 9, 312-15(Sep 1971). (In Czech).

Although the nuclear emulsions are still the most widely used personnel dosimeters for fast neutron dose equivalent measurements, they do not completely meet all desired requirements. In this review, some new dosimetric techniques of personnel neutron dosimetry are described. It is the method of nuclear track registration in combinations of fission materials and plastics, the possibility of utilizing LiF thermoluminescent dosimeters with and without moderators, and activation techniques. (auth)

9548 PROFESSIONAL EXPOSURE TO IONIZING RADIATION IN THE CSSR IN THE YEAR 1969. Chysky, Jaromir (Inst. of Hygiene and Epidemiology, Prague); Singer, Jan; Trousil, Jaroslav; Hospes, Miroslav. Jad. Energ.; 17: No. 9, 296-307 (Sep 1971). (In Czech).

During 1969, exposure was measured in 6500 persons engaged in work with ionizing radiation. The results of measurements supplemented by personal data of controlled persons were subject to hygienic evaluation in 4308 persons exposed to gamma radiation and x rays. Comparison of individual groups of followed up persons was from the point of view of statistical distribution of exposures carried out by means of a variant of the Smirnov-Kolmogorov's test. The average exposures were very low in 1969. Significantly higher exposures were found in industry, especially at defectoscopy workplaces. In public health establishments, higher exposures were found in workers handling uranium. Classification of controlled persons according to the height of annual exposure and sex, degree of qualification, age groups, duration of work with radiation sources, size of the workplaces, and type of work disclosed some further groups with higher exposures. Monthly exposures exceeding 400 mR were subject to a separate evaluation, their frequency in individual groups of workers was estimated and their cause evaluated. (auth)

9549 CALCULATED EFFECTIVE ATOMIC NUMBER AND KERMA VALUES FOR TISSUE-EQUIVALENT AND DOSIMETRY MATERIALS. Jayachandran, C. A. (Christian Medical College Hospital, Vellore, India). Phys. Med. Biol.; 16: No. 4, 617-23 (Oct 1971).

The calculated value of the effective atomic number ($\bar{z}_T$) of 7.23 for lithium tetraborate ($Li_2B_4O_7$) agreed closely with the value of 7.22 for soft tissue of composition $C_5H_{40}O_{18}N$. For excised muscle specimens the experimental value (7.42) obtained by Spiers for $\bar{z}_T$ was very nearly equal to the corresponding calculated value (7.46) for the composition (ICRU) of striated muscle. A similar comparison showed that the composition for bone given by Woodard with a higher content of calcium and phosphorus gave a value of $\bar{z}_T = 13.3$, in closer agreement with the measured value of 13.8 obtained by Spiers. The calculated values of $\bar{z}_T$ and kerma per roentgen for lithium tetraborate and lithium fluoride for photon energies below 1 MeV showed that lithium borate ($Li_2B_4O_7$) is a better substitute for soft tissue than lithium fluoride. (auth)

9550 ALPHA RADIATION, AN EXTERNAL RADIATION HAZARD. Harvey, J. R. (Berkeley Nuclear Labs., Eng.). Health Phys.; 21: No. 6, 866-8(Dec 1971).

A theoretical model is presented for calculation of the dose from plane sources of alpha activity present on the skin surface. The α dose rates due to ^{239}Pu, ^{241}Am, and ^{242}Cm were evaluated as a function of distance and taken as corresponding roughly to the depth dose curve within skin uniformly contaminated. It was concluded that α particles from activity near the skin surface on trunk, face, arms, and legs would irradiate the vulnerable basal epidermal layer in a significant percentage of individuals, the dose rate being in the range 0 to 10,000 rem/hr for levels of 1 $\mu Ci/cm^2$ and critically dependent on the depth of the epidermis. It is suggested that in British codes of practice there is an inconsistency between permissible contamination and permissible dose levels. (UK)

9551 SIMULTANEOUS ESTIMATION OF EXPOSURE AND TIME ELAPSED SINCE EXPOSURE USING MULTIPEAKED THERMOLUMINESCENT PHOSPHORS. Spurny, Z. (Nuclear Research Inst., Prague). Health Phys.; 21: No. 6, 755-61(Dec 1971).

Knowledge of the time elapsed since a radiation exposure may be useful in personnel monitoring, as for example in determining the time of occurrence of an over exposure or a nuclear accident, or in the choice of a therapy procedure, etc. The application of the multipeaked thermoluminescent phosphors is described, such as natural CaF_2, and Harshaw's type of LiF, for the simultaneous estimation of the exposure and the time elapsed since this exposure. Natural CaF_2 used for this purpose has three types of traps, so that the glow curve showed three maxima at about 100, 180, and 260°C. From the area under the 260° peak the exposure could be calculated within the range from a few millirads to some kilorads. The spontaneous decay of the electrons from shallow traps at normal temperatures (fading) with time after exposure led to the decrease of the peak areas. The 100° peak decayed most rapidly, and after about a month the decay of the 180° peak was observable. By measuring the ratios of the areas under the peaks, or of the peak heights, the time elapsed since the exposure could be assessed with a precision of about 10% for the range from a few hrs up to a thousand days. These ratios were independent of the exposure, the LET, and the dose rate. LiF phosphor appeared to offer similar possibilities. Preparation of a dosimeter, its parameters, and a technique for the simultaneous measurement of both quantities of both quantities are described, and an application of this principle in personnel monitoring is discussed. (auth)

9552 EXPOSURE OF THE POPULATION OF THE CSSR TO IONIZING RADIATION IN X-RAY DIAGNOSTICS. Kunz, E. Radioisotopy; 11: No. 4, 459-78(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The number of different types of diagnostic x ray examinations in various age groups of the population was studied during 1965 and 1966 in three regions of the CSSR. Analysis of various factors disclosed that the results obtained during this study may be representative for the whole country. The data indicate that on an average every citizen is x rayed approximately once per year. Of the total, examinations of lung and heart amounted to 60%; they were carried out in half of the cases by the mass-miniature radiography. With the use of data from a previous study of average dose in persons undergoing different types of x ray examinations, mean population gonad dose (66 mR) and genetically significant dose (37 mR) were evaluated. The population (per capita) mean bone marrow dose from diagnostic radiography was estimated to range between 70 and 185 mrad per year. The benefits from diagnostic radiography are undoubtedly greater than the risk connected with the exposure, however, it is possible and therefore necessary to reduce the radiation dose. (auth)

9553 PROFESSIONAL PERSONNEL EXPOSURES TO IONIZING RADIATION IN CSSR IN THE YEARS 1966 TO 1968. Chysky, Jaromir; Singer, Jan; Trousil, Jaroslav; Hospes, Miroslav. Radioisotopy; 11: No. 4, 479-95(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

In the year 1966 personnel exposures were measured in 3968 persons working with ionizing radiation. During 1967 and 1968 the number of radiation workers increased to more than 5000. Gamma and x ray exposure data in the range from 10 mR to 5 R were evaluated by computer. Higher exposures or beta exposures up to 1000 R were evaluated graphically. The measured values and the personal data of the workers were then transmitted to the punched band of a computer and statistically evaluated. A comparison of differently numerous groups of controlled persons is difficult and often impossible. Therefore, for the values found in the year 1966, there was established by means of the Smirnov–Kelnogorov test the statistical significance of differences in the exposure distribution of individual groups. In 1966, 84.16 percent of controlled persons were exposed to less than one tenth of the maximum permissible dose of 5 R, in 1967 it was 88.79 percent of controlled persons, and in 1968 it was 88.79 percent of controlled persons. Only 27, 6, and 10 persons respectively of the total number received more than 5 R. Very low average values were obtained also by evaluation of the monthly exposures. By detailed statistical processing of data, groups of workers could have been revealed which showed values somewhat higher than average, but which are nevertheless within the permissible level. (auth)

9554 TESTING FOR PERSONNEL DOSES FROM RADIOMETRIC GAUGES FOR DENSITY AND MOISTURE. Hoenig, A.; Pospisilova, L. Radioisotopy; 11: No. 4, 497-504(1970). (In Czech).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

The results of comparing the γ radiation dose emitted from radiometric gauges produced by ten prominent producers of gauges for depth and surface measuring of relative density and humidity are described. The instruments were tested for a year in laboratory tests at normal and extreme temperatures as well as in field tests. The personnel exposures in a number of parts of the body were monitored by various techniques. (auth)

9555 ESTIMATION OF MICRODOSE FROM LET SPECTRUM, DETERMINED BY TISSUE-EQUIVALENT PROPORTIONAL COUNTER. Chorvat, D.; Kollar, J.; Slovak, J. Radioisotopy; 11: No. 4, 521-35(1970). (In Slovak).

From second national radiological symposium; Jachymov, Czechoslovakia (20 Apr 1970).

Problems connected with the experimental estimation of microdose quantities of radiations in biological material are briefly discussed. Factors influencing the estimation, as well as equipment and some operational experiences, are described. The possible mathematical approach to pulse-height spectrum evaluation to obtain LET spectrum corresponding to interacting radiation and certain tissue-equivalent material thickness used in tissue-equivalent proportional counters are discussed. (auth)

Radiation Protection

Refer also to abstracts 9228 and 9542.

9556 (BNL-16255) STANDARDS, STATISTICS AND STERNGLASS: GUILT BY ASSOCIATION. Hull, Andrew P. (Brookhaven National Lab., Upton, N. Y.); Shore, Ferdinand J. (Queens Coll., New York). [1971]. 54p. (CONF-711119-2). Dep. NTIS.

From sixth annual topical symposium on radiation protection standards; Richland, Wash. (2 Nov 1971).

Existing radiation protection standards have been criticized on the grounds that radiation effects have been under-evaluated by the standards setting bodies. It has been postulated that the added risk at the presently permitted maximum exposure rate (500 mR/yr) will lead to an additional 61,880 deaths per million children born, and that concurrent increases in effluent releases from several nuclear facilities and in infant mortality in adjacent counties and/or states (as compared with that for more distant ones) provides evidence that low-level radiation may have already produced more serious effects than believed possible when radiation standards were formulated. It is concluded that the above argument uses an extreme interpretation of data from studies by Stewart and Kneale and ignores data from other contrary studies. The effluent release and infant mortality data appear to be selected to the exclusion of other data leading to opposite conclusions. Such effluent produced doses as have been considered have been misrepresented. When examined in the context of the actual or calculated average effluent doses to the populations at risk and of other sources of exposure, the claimed effects cannot reasonably be related to effluent releases. Most appear to be insignificant statistical variations about long term trends. Other more plausible causes for infant mortality can be adduced. (auth)

9557 SOLAR FLARES AND THE CONCORDE. Pochin, E. E. (University Coll., London). Brit. Med. J.; 4: No. 5782, 297(30 Oct 1971).

Various criticisms are made of a previous leading article, (British Med. J.; 4: No. 5780, p 127 (16 Oct 1971)). Reference is made to the fact that biological shielding by a layer of Micrococcus radiodurans would be no more effective than an equally thick layer of water or clothing. The maximum exposure recommended by the ICRP is discussed in relation to the general public as opposed to occupational limits. The descent to lower altitudes to avoid major flares, and the carrying of instruments to determine major rises in radiation levels, is mentioned. (UK)

Safety Procedures

Refer also to abstract 9496.

9558 (WASH-1192) OPERATIONAL ACCIDENTS AND RADIATION EXPOSURE EXPERIENCE WITHIN THE UNITED STATES ATOMIC ENERGY COMMISSION, 1943-1970. (Division of Operational Safety (AEC), Washington, D. C.). Fall 1971. 126p. Dep. GPO $1.25.

The protection of persons and property against potential hazards in Atomic Energy Commission (AEC) activities has been a fundamental concern of the AEC from the earliest developments in the use of atomic energy. Data are summarized on occupational injury and fatality through 28 years of the development of the atomic energy industry under the guidance and direction of the AEC and its predecessor, the Manhattan Engineer District, 1943 through 1970. During the 28 year period there were only six deaths attributable to nuclear causes. Fatalities from all causes totaled 295 during the period. Of this number, 181 occurred in construction, 98 in AEC operations (production, research, and services), and 16 in Government functions. During this period, there were 17,934 lost-time injuries attributable to all accidental causes. This gives a 28-year frequency rate (number of injuries per million man-hours) of 2.91. Of the lost-time injuries 51% (9,147) occurred in AEC operations. This was the experience of 539,605,388 man-days of potential accident exposure, which produced over four billion man-hours of work and a 28-year frequency rate of 2.12. Only 38 of the 9,147 lost-time injuries, four-tenths of one percent (0.4%), were caused by nuclear radiation. This is equivalent to a frequency rate of 0.01. Data are also summarized on incidents (including off-site accidents) involving loss or damage to AEC or other property of over $25,000, including costs for cleaning (including decontamination), renovating, replacing, repairing, or rehabilitation of structures, equipment, or property. (C.H.)

Legal Aspects

9559 (RT/GIU-(71)1) CONSIDERATIONS ON THE ATTRIBUTIONS OF CNEN INSPECTORS. Nocera, F.; Carbone, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 12 Jul 1971. 21p. (In Italian). Dep. NTIS (U. S. Sales Only).

The provisions contained in Italian nuclear energy laws relevant to the authority and duties of Italian Atomic Energy Commission (CNEN) inspectors are reviewed. It is pointed out that this inspecting body is unique and cannot be found in the corresponding legislation of other countries. The implications of the provisions considered for the inspecting statutory tasks of the CNEN are discussed. (C.H.)

9560 LEGAL ASPECTS OF RADIOCHEMISTRY. Meeting Held in London, February 25, 1971. Proc. Soc. Anal. Chem.; 8: No. 10, 204-16(Oct 1971). (CONF-710219).

Summaries of the three papers presented at the meeting are given. Application of the "Code of Practice for the Protection of Persons Exposed to Ionizing Radiations in Research and Teaching" within Radiochemical Laboratories. Rees, J. M. (Dpt. of Employment, London); The Radioactive Substances Act 1960. Osmond, R. G. D. (Dpt. of Environment, London); The Design of Radiochemical Laboratories. Hamilton, E. I. (Radiological Protection Service, Sutton, Eng.). (UK)

Medicine

Refer also to abstracts 8758, 8984, and 8985.

Protective Substances

Refer also to abstracts 9628 and 9666.

9561 KINETIC REGULARITIES IN THE RADIOSENSITIZING ACTION OF INHIBITORS-ANTIOXIDANTS ON TUMOR CELLS. Afanas'ev, G. G.; Pelevina, I. I.; Lipchina, L. P.; Emanuel, N. M. (Inst. of Chemical Physics, Moscow). Tr. Mosk. Obshchest. Ispyt. Prir.; 32: 15-18(1970). (In Russian).

A study was made of the combined action of propylgallate, repeatedly injected intraperitoneally to mice with inoculated subcutaneous lymphosarcoma NKLy, and local irradiation of tumors with a dose of 600 R. Tumors are divided into sensitive and resistant groups. Propylgallate enhances the lethal effect

exerted by irradiation on tumor cells, as evidenced by an increase of the number of tumors. The rate of growth of the developing tumors decreases. (auth)

9562 LATE SOMATIC EFFECTS IN RATS TREATED WITH 2-β-AMINOETHYLISOTHIOURONIUM-Br-HBr AND EXPOSED OR NOT TO X IRRADIATION. Fridman-Manduzio, A.; Maisin, J. R.; Leonard, A.; Mattelin, G. (Univ., Liege. Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Strahlentherapie; 142: No. 1, 80-7(Jul 1971).

The causes of life-shortening effects of AET and of 300 R of x-rays were studied in 8, 17, 60, or 200 day old male and female Wistar rats given or not an intraperitoneal injection of AET before exposure. In all groups of rats studied, the three principal causes of death were glomerulosclerosis, cancer and infection. In the non-treated rats, the incidence of spontaneous glomerulosclerosis was high. AET given alone or before a dose of 300 R of x-rays increases, in most of the groups of male and female rats, the incidence and decreases the latency period of spontaneous glomerulosclerosis. This was particularly marked in the male injected with AET at 17 days of age. Infectious diseases and especially pulmonary infections were frequent in all groups of rats. (auth)

9563 MODIFICATION OF RADIATION-INDUCED DAMAGES IN CHROMOSOMES OF CREPIS CAPILLARIS SEEDS BY INHIBITORS OF CELL METABOLISM. Kotomina, I. F.; Mitrofanov, Yu. A. (Inst. of General Genetics, Moscow). Tsitol. Genet.; No. 2, 144-9(1971). (In Russian).

The postirradiation modification of the effect of puromycin and 5-fluoro-2-deoxyuridine radiation was investigated on the Crepis capillaris. Puromycin-induced modification occurs due to an increase in the amount of dicentrics and rings. Modifying effects were observed in G_1 and S phases. Fudr-induced modification can account for the increase in the number of gaps and aberrations with fragments of chromosomes that failed to reunite. In this case a real decrease in the number of dicentrics and rings takes place. The modifying effect was observed in S phase. It is suggested that modification of chromosome breaks occurs at the level of potential damages. (auth)

9564 EFFECT OF pH ON THE UPTAKE OF CYSTEAMINE IN VITRO AND IN VIVO. Modig, H. G.; Edgren, M.; Revesz, L. (Karolinska Inst., Stockholm). Int. J. Radiat. Biol.; 20: No. 3, 297-9(1971).

A brief summary is given of previous studies on the pH dependence of the radioprotection afforded by -SH compounds. The present investigation was performed with the purpose of measuring the uptake of cysteamine in mammalian cells in vitro and its absorption in an animal in vivo, at different pH levels, in order to elucidate the basis of the pH dependence of radioprotection by -SH compounds. Ehrlich ascites tumour cells, from mice, were used in the in vitro experiments conducted at pH 5.5 to 8.0, in which the intracellular content of non-protein SH groups was determined; a gradual increase in the NPSH content occurred with increasing pH. In the in vivo experiments cysteamine at pH 5.5 to 7.2 was injected intraperitoneally into mice. The data obtained indicated that 41.7 and 73.8% of the injected cysteamine was absorbed from the peritoneal cavity during 10 and 20 min., respectively, when the pH was 5.5, or 69.7 and 85% at pH 7.2. Thus increasing pH facilitated both the incorporation and absorption of cysteamine. Mechanisms are discussed. It seems probable that the enhanced protection afforded by thiols with increasing pH may be attributed to this increased incorporation or absorption of the protector. Also, the penetration of the protector through cell membranes may possibly be facilitated by increased dissociation at higher pH values. (UK)

9565 EFFECT OF CHEMICAL SENSITIZATION ON REPAIR OF POTENTIALLY LETHAL IRRADIATION INJURY IN RHIZOPUS STOLONIFER SPORANGIOSPORES. Sommer, N. F. (Univ. of California, Davis); Dupuy, P.; Rabatu, Arlette. Radiat. Bot.; 11: No. 5, 363-6(Oct 1971).

Rhizopus stolonifer sporangiospores were sensitized to γ radiation by soaking several hrs in iodoacetamide solution. Plating immediately after irradiation or after a 48-hr holding period permitted an evaluation of the effect of sensitization on repair. Sensitized spores always exhibited a recovery from potentially lethal irradiation injuries. However, the size of the repaired fraction was always moderately smaller if the spores were sensitized to iodoacetamide prior to irradiation. (auth)

9566 USE OF A SUSTAINED-RELEASE MULTIPLE EMULSION TO EXTEND THE PERIOD OF RADIOPROTECTION CONFERRED BY CYSTEAMINE. Gresham, P. A.; Barnett, M.; Smith, S. V. (Univ. of Birmingham, Eng.). Nature (London); 234: No. 5325, 149-50(19 Nov 1971).

Practical applications of radioprotective agents are limited by their toxicity and because they are often metabolized so rapidly that they give protection for only a short time. Some experiments are described in which cysteamine was incorporated in a sustained-release multiple emulsion in an attempt to extend the duration of protection in mice. Results were compared for cysteamine in aqueous solution and in emulsion, the latter comprising liquid paraffin containing "Arlacel 83" (sorbitan sesqioleate) detergent, added to an aqueous solution of "Tween 80" (Honeywell Atlas Ltd.). It is noted, however, that a more stable emulsion may be prepared using Squalene and "Arlacel A". Parameters studied were spleen weight, colony counts, and percentage of spleens showing confluence. When cysteamine was administered in aqueous solution, protection was maximum when given 7 to 10 min. before whole-body irradiation (700 R) but decreased to nearly zero when there was an interval of 20 min. When cysteamine was administered in emulsion, however, there was again a rapid increase in radioprotection during the first few minutes, and no decrease during the following 15 min., but in fact a further increase that remained high for at least 1.5 hr. Uptake of ^{59}Fe into red cells was measured in some mice to give an estimate of total body erythropoiesis: a high level of protection was also maintained. Prolonged protection also occurred on irradiation even at 90 min., after administration of the protective agent. (UK)

9567 ISOLATION OF PLANT MELANINS AND STUDY OF THEIR RADIOPROTECTIVE PROPERTIES. Bidzilya, N. I.; Zezina, N. V. (Inst. of Plant Physiology, Kiev). Fiziol. Biokhim. Kul't. Rast.; 3: No. 1, 55-60(1971). (In Russian).

Infrared, ultraviolet, and EPR spectra of melanins were determined following extraction from Vicia faba. Alkali soluble melanins had paramagnetic centers/g of 3.7×10^{18}; water soluble melanins, 7.6×10^{17}. Gamma-irradiated white mustard seeds were treated with alkali soluble and water soluble melanins and it was found that the water soluble melanins had a protective effect as determined by improved germination time and increased length and dry weight of seedlings. (H.L.W.)

9568 ON A BARRIER IN THE DISTRIBUTION OF RADIOPROTECTORS BETWEEN INOCULATED TUMORS AND NORMAL TISSUES. Sumarukov, G. V.; Kagan, V. E. Tr. Mosk. Obshchest. Ispyt. Prir.; 32: 211-13(1970). (In Russian).

The radioprotective effect depends on the value of changes of the stationary red-ox potential of tissues exposed to radiation. The change of the potential in the tissues of animals with transplanted solid tumors depends on the method of administration of radioprotectors: with intraperitoneal injections the potential changes occur in normal tissues only; with injections into the tumor it changes only within the tumor. The kinetics of changes of the potential reflect the kinetics of changes in the radiosensitivity of tissues after administration of radioprotectors. (auth)

9569 PROTECTIVE EFFECT OF CYSTEAMINE-S-PHOSPHATE (CYSTAPHOS) ON HAEMOPOIETIC STEM CELLS IN IRRADIATED MICE. Vacek, A.; Semenov, L. F.; Rotkovska, Dolores; (and others) (Inst. of Biophysics, Brno. Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Folia Biol. (Prague); 17: No. 5, 340-7(1971).

The duration of the protective effect of Cystaphos, applied either intraperitoneally, subcutaneously or per os, on radiation mortality and on survival of haemopoietic spleen and bone marrow stem cells was investigated in irradiated mice. Pretreatment with Cystaphos resulted in an increase in the number of endogenous haemopoietic spleen colonies. The effect was significant for time intervals up to 1 hour between injection and irradiation. The onset of haemopoietic recovery was quicker in the pretreated mice and a significant improvement was found during the first 7 days following the irradiation. The application of Cystaphos caused a decrease in oxygen in the muscle, but no change was recorded in the spleen. Irradiation in pure oxygen atmosphere did not diminish the degree of protective action of Cystaphos. (auth)

9570 INFLUENCE OF A RADIOPROTECTIVE SUBSTANCE AET-BrHBr (AMINOETHYLISOTHIURONIUM-BrHBr) UPON THE SURVIVAL HALF-TIME OF ERYTHROCYTES LABELED WITH ^{51}Cr IN WHOLE-BODY X IRRADIATED RATS. Dienstbier, Z.; Pospisil, J.; Prouza, Z. (Charles Univ., Prague). Strahlentherapie; 142: No. 1, 88-92(Jul 1971).

The influence of a radioprotective substance aminoethylisothiuronium-BrHBr upon the survival half-time of erythrocytes labeled with ^{51}Cr in whole-body 600 rd x-irradiated rats was studied. In previous work it was found that whole-body irradiation shortened the survival of erythrocytes in direct proportion to the size of the absorbed dose. The current study shows that AET–BrHBr influences favorably the survival half-time of erythrocytes,

from 39.6 to 51.8% to 66.6 to 70.6%, when half-time of erythrocytes in control groups was given as 100%. (auth)

9571 EFFECT OF CIS-DICHLORODIAMINE PLATINUM(II) ON THE POST-IRRADIATION LETHALITY IN MICE AFTER IRRADIATION WITH X-RAYS. Zak, Miroslav; Drobnik, Jaroslav (Charles Univ., Prague. Inst. of Macromolecular Chemistry, Prague). Strahlentherapie; 142: No. 1, 112-15(Jul 1971).

An investigation was carried out of the effect of cis-Pt (II), applied intraperitoneally, on the survival of mice after a single-dose whole-body irradiation with x-rays. The irradiation dose was 700 R, the animals were under observation 30 days after exposure, and cis-Pt (II) was introduced 48, 24, and 1 hour before irradiation, and 1 and 24 hours after irradiation. It was found that the application after irradiation impairs the survival. The most favorable protective effect was achieved with an application 24 hours before irradiation. This finding is discussed by assuming that in the case of application of cis-Pt (II) after exposure the damage due to the ionizing radiation and toxicity of cis-Pt (II) can be added to each other. An application 24 hours before irradiation leads to a decrease in the mitotic activity of cells of the bone marrow, as established earlier, and the ionizing radiation probably affects the cells in a state of the maximal mitotic attenuation. However, the principal difference between the effect of an application of half the dose one hour before and one hour after irradiation should be sought in some other rapidly occurring processes. (auth)

Radiation Sickness and Injuries

9572 REPORT OF A PERFORATING AND INCISED WOUND OF THE LEFT FOREFINGER CONTAMINATED WITH ^{241}Am. Ohlenschlaeger, Lothar (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie; 142: No. 1, 73-9(Jul 1971). (In German).

Therapeutic measures are described for a punctured and incised wound in the tip of the left index finger that was contaminated with ^{241}Am. Three wound excisions reduced the activity from 244 μCi to 0.7 μCi. Intravenous injections of 0.5 g DTPA were given on the first and twelfth days. The practical application of DTPA in cases of wound contamination with transuranium elements is discussed. A discussion is given of initial results of activity analyses of blood, urine, and feces carried out over a period of 26 days. (auth)

Radiodiagnosis

Refer also to abstracts 9297, 9304, 9431, 9454, 9542, and 9552.

9573 (UARAEE-112) EXPERIMENTAL STUDIES OF THE BIOLOGICAL SAFETY OF ^{99m}Tc-COATED CARBON PARTICLES SUSPENSION INTENDED FOR RADIODIAGNOSTIC HUMAN LUNG SCANNING. El-Garhy, M.; El-Bayoumy, S.; Abdullah, E.; Madkour, M. K.; El-Haleem, S. A.; Rafael, N. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Chemistry Dept.). 1971. 49p. Dep. NTIS (U. S. Sales Only).

Results are reported from studies of acute toxicity, biological safety, biological disposition, and tissue distribution of ^{99m}Tc-coated carbon particulates in suspensions intended for use for radiodiagnostic human lung scanning. The experimental results indicate that the radiologically inert preparation displays a considerable margin of safety, freedom from toxic manifestations in clinically useful dosage, and a highly selective deposition in the lungs. The findings are discussed and evaluated with respect to analogous data by other authors, and the advantages of this product for pulmonary scintigraphy are summarized. (auth)

9574 PRODUCTION, PROCESSING, AND APPLICATION OF RESEARCH REACTOR PRODUCED ^{18}F RADIOPHARMACEUTICAL. Dunson, George L.; Crofford, William C.; Hosain, Fazle; Jones, Alfred E.; Mellor, Marilyn K. (Walter Reed Army Medical Center, Washington, D. C.). Nucl.-Med.; 10: No. 3, 256-64(30 Sep 1971).

Fluorine-18 was produced in a low power research reactor from enriched lithium-6 carbonate. The radiopharmaceutical quality ^{18}F was produced within 15 min by separating it from tritium and lithium. Evaluation of radiochemical purity and biological assay showed the product could be administered orally or parenterally. Oral administration to fasting patients resulted in high quality bone scans. (auth)

9575 PHAGOCYTIC ACTIVITY OF THE LIVER AS A MEASURE OF HEPATIC CIRCULATION: A COMPARATIVE STUDY USING ^{198}Au AND ^{99m}Tc-SULFUR COLLOID. Mundschenk, H.; Hromec, A.; Fischer, J. (Univ., Mainz). J. Nucl. Med.; 12: No. 11, 711-18(Nov 1971).

The disappearance rate of injected colloids can be used to estimate blood flow in the liver. A comparative study of the disappearance of ^{198}Au- and ^{99m}Tc-sulfur colloid from the bloodstream clearly showed that both agents differ appreciably from each other in their behavior. The most essential differences are summarized. (C.H.)

9576 USE OF ^{13}N IN STUDIES OF AIRWAY CLOSURE AND REGIONAL VENTILATION. Greene, Reginald; Hoop, Bernard; Kazemi, Homayoun (Massachusetts General Hospital, Boston. Harvard Medical School, Boston). J. Nucl. Med.; 12: No. 11, 719-23(Nov 1971).

The technique and potential clinical advantages of airway closure and pulmonary ventilation studies with high-specific-activity ^{13}N-labeled molecular nitrogen are presented. External detection of ^{13}N is described in ventilation studies, and the simultaneous monitoring of lung volume changes and of expired ^{13}N boluses are described in airway closure measurements. The application of these studies may be of particular significance in the early detection of obstructive lung disease and pathophysiological mechanisms involving the lung in cardiorespiratory disorders. (auth)

9577 EFFECTS OF CORONARY ARTERIAL INJECTION OF RADIOALBUMIN MACROAGGREGATES ON CORONARY HEMODYNAMICS AND MYOCARDIAL FUNCTION. Poe, Norman D. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. J. Nucl. Med.; 12: No. 11, 724-31(Nov 1971).

The effects of intracoronary arterial injections of ^{131}I-labeled albumin macroaggregates on coronary hemodynamics and myocardial function were studied in normal, anesthetized dogs to evaluate the possible use of this technique for determination of regional myocardial blood flow. Slow injections of macroaggregates containing less than 0.05 mg albumin with no particles greater than 60 to 70 microns in maximum diameter can usually be given directly into the left anterior descending coronary artery with no significant changes in coronary flow, myocardial contractile force, arterial pressure, or the electrocardiogram. As the mass of albumin and/or particle size is progressively increased, a sequence of functional changes evolves. Coronary flow is reduced, followed immediately by transient hyperemia. Contractile force falls. Only after marked flow and contractile changes have been produced do abnormalities in arterial pressure and the ECG develop. The course of events is similar to that resulting from progressive coronary arterial occlusion. It is concluded that carefully prepared radioactive particles, in amounts sufficient for external scintillation scanning, can be injected into the coronary arteries without detectable alterations in function, and that the technique is suitable for acute and chronic determinations of regional myocardial perfusion both experimentally and clinically. The functional effects in the presence of coronary or myocardial disease are yet to be determined. (auth)

9578 MEASUREMENT OF CARDIAC SHUNTING WITH TECHNETIUM-LABELED ALBUMIN AGGREGATES. Gates, Gary F.; Orme, Harry W.; Dore, Earl K. (Memorial Hospital Medical Center, Long Beach, Calif. Children's Medical Center, Long Beach, Calif.). J. Nucl. Med.; 12: No. 11, 746-9(Nov. 1971).

Right-to-left cardiac shunting was detected and quantitated in three children with tetralogy of Fallot after intravenous injection of ^{99m}Tc-tagged MAA. The test is performed rapidly, and the patient does not require heavy sedation. The method is calculated to have at least a 6,000-fold factor of safety. The only precaution required is that a particle size measurement of each MAA suspension be made before injection. Preliminary results indicate the procedure deserves further investigation. (auth)

9579 CORRELATION OF PULMONARY PHOTOSCAN AND ANGIOGRAM AS MEASURES OF THE SEVERITY OF PULMONARY EMBOLIC INVOLVEMENT. McIntyre, Kevin M.; Sasahara, Arthur A. (Veterans Administration Hospital, West Roxbury, Mass. Harvard Medical School, Boston). J. Nucl. Med.; 12: No. 11, 732-8(Nov 1971).

The observation that the hemodynamic impact of pulmonary embolism usually is directly proportionate to the extent of embolic obstruction by angiography and the extent of the perfusion defect by lung scan has emphasized the importance of an accurate assessment of the magnitude of embolic involvement. This may prove to be particularly true in patients with underlying heart or lung disease in whom the contribution of embolism to the hemodynamic abnormality may be very difficult to define. The extent of embolic involvement as assessed by pulmonary photoscanning was compared to the assessment by selective pulmonary angiography in patients free of underlying cardiopulmonary disease. It was concluded that, although the overall correlation between the two techniques was good, either technique could significantly underestimate the magnitude of embolic involvement so that the use of both techniques may be essential to determine the extent of embolic involvement with reasonable accuracy. (auth)

9580 PARATHYROID SCANNING WITH ^{75}Se-SELENOMETHIONINE AND GLUCAGON STIMULATION. Ashkar, Faud S.;

Naya, Juan L.; Smith, Edward M. (Univ. of Miami, Fla.). J. Nucl. Med.; 12: No. 11, 751-3(Nov 1971).

A method is described for localizing parathyroid adenomas with the use of ^{75}Se-selenomethionine and the scintillation camera after glucagon stimulation. (C.H.)

9581 METASTATIC EXTRAOSSEOUS OSTEOSARCOMA TO THE LIVER: A CASE DEMONSTRATED BY ^{85}Sr AND ^{99m}Tc-COLLOID SCANNING. Dalinka, Murray K.; Fineash, Arlie E.; Aston, James K. (Air Force Medical Center, Lackland AFB, San Antonio, Tex.). J. Nucl. Med.; 12: No. 11, 754-5(Nov 1971).

A method is described for the localization of extraosseous osteosarcoma of the kidney with hepatic metastases by scintigraphy using ^{99m}Tc-sulfur colloid followed by scintigraphy using ^{85}Sr. (C.H.)

9582 SCINTIGRAPHIC DEMONSTRATION OF CEREBRAL INFARCTON IN A WATERSHED DISTRIBUTION. Kilgore, Basset B.; Bonte, Frederick J. (Univ. of Texas, Dallas). J. Nucl. Med.; 12: No. 11, 756-7(Nov 1971).

The possibility of a cerebral vascular accident was studied in a patient following surgery. Thirty minutes after the administration of 200 mg of potassium perchlorate by mouth the patient was given an intravenous dose of 10 mCi of ^{99m}Tc as sodium pertechnetate. One hour thereafter a rectilinear scan was carried out with a dual 5-in. crystal unit. The anterior view showed a right paramedian, strip-like lesion which, on the right lateral view, extended posteriorly in a nodular configuration through the frontal and parietal regions into the occipital region. Because the area of tracer localization seemed to lie along the border between the anterior and middle cerebral circulations, a scan diagnosis of cerebral infarction in a watershed distribution was made. (C.H.)

9583 RADIOACTIVITY PROFILES OBTAINED BY LONGITUDINAL WHOLE BODY SCANNING. POST-OPERATION SUPERVISION OF THYROID CANCERS. Massin, J. P.; Thomopoulos, P.; Karam, J.; Savoie, J. C. (Groupe Hospitalier la Pitie Salpetriere, Paris). J. Radiol., Electrol., Med. Nucl.: 52: No. 8-9, 501-10(Aug-Sep 1971). (In French).

Radio-iodine profiles of 175 patients suffering from differentiated thyroid carcinomas were obtained, 15 of the patients exhibiting one or more fixing metastasis. The profiles were obtained by unidirectional whole-body scanning in the course of routine examinations. Because of its simplicity and short duration this method might prove worthwhile in the post-operation supervision of thyroid carcinomas. (France)

9584 PREPARATION AND APPLICATIONS OF MACROCLUSTERS OF ^{64}Cu AND GELATINE. Gelis, Christian (to Commissariat a l'Energie Atomique). French Patent 2,043,487. 19 Feb 1971. Filed 29 May 1969. (In French).

A method of preparing macroclusters of ^{64}Cu and gelatin intended for pulmonary scintigraphy by intraveneous injection (or hepatic scintigraphy) is described. It involves producing a Cu-gelatin complex: an alkaline ^{64}Cu solution is added in the cold to a gelatin solution, precipitation is induced in the warm with a tanin solution, and the suspension is completed by adding distilled water. The quantities of constituents added are calculated in such a way as to preserve the neutrality (pH = 7) and to ensure that ionic Cu is not contained in the suspension, and that gelatin does not remain in solution. (France)

9585 BRAIN SCAN IN HYPERPARATHYROIDISM. Mishkin, Fred; Weber, Klaus (Indiana Univ., Indianapolis). J. Nucl. Med.; 12: No. 11, 763-4(Nov 1971).

Increased concentration of a variety of ionic radionuclides occurs in association with areas of increased bone turnover. Hyperparathyroidism can also present a picture of diffuse increase of skull activity on the ^{99m}Tc-pertechnetate brain scan. A case is presented in which results of a ^{99m}Tc-pertechnetate brain scan provides a striking example of this phenomenon. (C.H.)

9586 OBSTRUCTIVE JAUNDICE CAUSED BY HEPATIC ARTERY ANEURYSM DEMONSTRATION BY RADIONUCLIDE IMAGING TECHNIQUES. Mehnert, Peter J.; Freeman, Leonard M. (Yeshiva Univ., New York. Albert Einstein Coll. of Medicine, Bronx, N. Y.). J. Nucl. Med.; 12: No. 11, 761-2(Nov 1971).

A case of obstructive jaundice secondary to an hepatic artery aneurysm is presented. The liver scan with ^{99m}Tc-sulfur colloid demonstrated a defect which subsequently filled with ^{131}I-human serum albumin activity. The ovoid shape of the blood-pool activity was proven to be aneurysm by angiography. Surgical confirmation was also obtained. (auth)

9587 ACCUMULATION OF ^{131}I-LABELED ALBUMIN IN A SUBDURAL HEMATOMA DEMONSTRATED BY CISTERNOGRAPHY. Alazraki, Naomi P.; Halpern, Samuel E.; Rosenberg, Roger N.; Ashburn, William L. (Univ. of California, San Diego). J. Nucl. Med.; 12: No. 11, 758-60(Nov 1971).

It has been reported that lesions that occupy the subarachnoid and subdural spaces are commonly associated with a lack of tracer activity at the site of the lesion on the radioisotope cisternogram. A case is described in which a subdural hematoma presented an accumulation of the tracer (^{131}I-albumin) rather than a lack of activity at the location of the lesion. (auth)

9588 PRIMARY ALDOSTERONISM: PREOPERATIVE TUMOR VISUALIZATION BY SCINTILLATION SCANNING. Conn, J. W.; Beierwaltes, W. H.; Lieberman, L. M.; (and others) (Univ. of Michigan, Ann Arbor). J. Clin. Endocrinol. Metab.: 33: No. 4, 713-16(Oct 1971).

A patient with hypokalemic primary aldosteronism, in whom a left adrenal tumor was visualized by selective adrenal venography, was given an intravenous tracer dose of ^{131}I-19-iodocholesterol. By means of an Anger camera, aided by a computer, increased radioactivity at the site of the tumor was visualized and increased unilateral uptake of radioactivity was established. The position of the tumor was confirmed surgically. The method may prove to be valuable in the preoperative determination of the site of the characteristically small aldosterone-producing tumor. (auth)

9589 ANGIOSCINTIGRAPHY STUDIES OF HANDS AND FEET. Paschke, K. G.; Huering, H.; Schoop, W.; Zeitler, E. (Landesversicherungsanstalt, Rheinprovinz, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 3, 333-9(Sep 1971). (In German).

An angioscintigraphic method for hands and feet is described which involves intraarterial injection of ^{131}I-labeled albumin macroaggregate following arteriography. To obtain reliable results, Priscol was injected intraarterially and the extremities were under an external pressure of 40 mm Hg. With respect to vascular occlusions, scintigraphy cannot replace angiography. With respect to necroses, gangrene, diabetic neuropathies, and sympathectomy, however, the diagnostic value of scintigraphy exceeds that of angiography. Scintigraphy also was advantageous in the differential diagnosis between tumors and arterio-venus shunts. (H.B.G.)

9590 SHUNT VOLUME DETERMINATIONS WITH RADIOACTIVE LABELED ALBUMIN PARTICLES FOR THE DIFFERENTIAL DIAGNOSIS OF BRAIN TUMORS. Bergmann, H.; Boeck, F.; Brenner, H.; Hoefer, R.; Dal Bianco, M. (Neurochirurgische Klinik, Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 3, 348-57(Sep 1971). (In German).

After injection of ^{131}I MAA into the internal carotic artery, the shunt volume was calculated in percent of the carotic flow. Mean shunt values were 1.9% for meningiomas, 5% for metastases, 13.2% for astrocytomas, and 30.4% for glioblastomas. The method allowed the differential diagnosis between metastases and gliomatose tumors of the brain as well as between poorly vascularized meningiomas and gliomas. (H.B.G.)

9591 BRAIN METASTASES IN SERIAL SCINTIGRAMS: INITIAL AND FOLLOW-UP OBSERVATIONS. Roesler, H.; Kinser, J.; Stalder, A. (Univ., Bern). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 3, 357-72(Sep 1971). (In German).

Serial pictures were taken at 4 second intervals after ^{99m}Tc pertechnetate injection in 56 tumor patients with known cerebral metastases. Only in 30 of the patients did the initial examination yield positive results. In more than half of the patients, ^{99m}Tc accumulation was weak. An early sign of metastases was a perifocal blood flow reduction. (H.B.G.)

9592 BONE SCINTIGRAPHY IN INCIPIENT HEMATOGENOUS OSTEOMYELITIS. Umek, H.; Stych, H. (Univ., Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 3, 397-9 (Sep 1971). (In German).

One case of hematogenous osteomyelitis was analyzed. After a minor injury, the patient complained about pain in the right femur. Bone x-rays were normal. Because of persisting pain, 3.0 μCi of ^{87m}Sr were injected intravenously. 30 minutes after injection, the right femur displayed a striking augmentation of radioactivity. Based on this fact and on other clinical observations, acute osteomyelitis was diagnosed. Only after 27 days did x ray examination show osteomyelitic changes in the femur. (H.B.G.)

9593 REPORT ON COMPLEX RADIOLOGICAL DIAGNOSIS OF THE PERITONEAL AND EXTRAPERITONEAL SPACE IN THE UPPER ABDOMINAL REGION (CONVENTIONAL X-RAY DIAGNOSIS, ANGIOGRAPHY, AND NUCLEAR MEDICINE). Muenster, W.; Lucas, D. (Humboldt Univ., Berlin). Radiol. Diagn. 12: No. 2, 181-7(1971). (In German).

Radiological diagnosis of diseases of the upper abdominal region was the main theme of a symposium held in Berlin in 1970. Inflammatory, cirrhotic, and cholestatic diseases of the liver were discussed. A special session was devoted to the detection of tumors and metastases in the liver by conventional radiography, angiography, and scintigraphy. Diseases of spleen and pancreas also were discussed. The last session treated primary tumors in the retroperitoneal space. Vertical venography, mesenteric arteriography, and the detection of functional disturbances in the gastrointestinal tract through radioisotopes were emphasized. (H.B.G.)

9594 DOUBLE RADIONUCLIDE PANCREATIC FUNCTION SCINTIGRAPHY BY A PROCESS COMPUTER. Hundeshagen, H.; Creutzig, H.; Dopslaff, H. (Institut fuer Nuklearmedizin und Spezielle Biophysik, Hanover). Radiol. Diagn. 12: No. 2, 212-22 (1971). (In German).

The metabolism of the radioactive indicator ^{75}Se-methionine and the topographic conditions of the pancreas compared with liver, intestine, and kidneys let the normal pancreatic scintigraphy in proportion of expense to the clinical value appear so disadvantageous that double radionuclide scintigraphy with a scintillation camera or a polycrystal scanner and of simple subtraction were introduced. Double radionuclide scintigraphy using ^{75}Se and ^{198}Au is described. A better judgement of the shape and pattern of accumulation is possible by the isolated representation of the deposition of radioactivity in the pancreas. Function curves of the regions of interest allow a differentiation of different tissues. A classification of accumulative defects with a complete representation of the organs in three stages is given. In a group of patients with suspicion of a space-requiring process a falsely negative result was not found; the rate of the falsely positive, however, was about 25%. This method gives important references to the clinic so that it may be used as a routine method despite considerable technical expense. (auth)

9595 METHOD OF MAGNIFICATION IN RADIOPHOTOGRAPHY. Stier, M.; Stargardt, A. (Forschungsinstitut fuer Tuberkulose und Lungenkrankheiten, Berlin, Humboldt Univ., Berlin). Radiol. Diagn. 12: No. 2, 295-9(1971). (In German).

The gain of image quality when direct x-ray magnification in radiophotography is used related to the generally used focus is estimated. Results of this technique in imaging chest, nasal sinus and hand, which satisfy from view of image quality are reported. The patient dose is discussed. (auth)

Radiotherapy

Refer also to abstracts 9151, 9152, 9639, 9641, 9642, 9644, 9645, 9649, 9650, and 10707.

9596 CONFORMATION RADIOTHERAPY. Kitagawa, Toshio; Mori, Tomoyuki; Okumura, Hiroshi; Ueda, Toshio; Yamashita, Nobuo (Aichi Cancer Center, Nagoya, Japan). Gan No Rinsho; 16: No. 4, 361-7(Apr 1970). (In Japanese).

Conformation radiotherapy is an external radiation technique developed for the use of radiation in the treatment of cancer and other malignant tumors and involves the selective irradiation of the focus alone. For this purpose, an individual or multiple block collimator that can move unsymmetrically is placed into the irradiation port of a 6 MeV linear accelerator to form an optional flux required in clinical use. This device can deliver a sufficient dose to the focus, decreases the unnecessary radiation dose that reaches the organs around the focus to a degree that can be clinically neglected, and makes it possible to prevent post-irradiation damage. At the same time, improvement in the result of distant irradiation may be expected. Complicity of this mechanism is independent of radiation planning, the technique is more simple and rapid than fixed radiation, and reproducibility is good. In addition, the primary focus and related lymph node system can be irradiated at the same time and homogeneously. The cure rate using this technique seems to be comparable with other methods of irradiation. Tumors of the lung, esophagus, upper maxilla, uterus, stomach, rectum, and urinary bladder are considered to be indicated for this method of irradiation. The permissible limit is 500 rads and the dose above that should be limited to the primary site or supplemented with two portal opposing-field irradiation or small-dose source irradiation. (Japan)

9597 TREATMENT OF BRAIN TUMOR BY RADIATION. Watari, Tsutomu (Tokyo Univ.). Rinsho To Kenkyu; 47: No. 4, 922-8(Apr 1970). (In Japanese).

The principle and concept of radiotherapy of brain tumors are given, centered on some cases treated in the Radiology Department, Tokyo University Hospital, together with notes on side effect, difference in radiosensitivity of brain tumors, and extension of therapeutic indications. The development of a combined use of radiation sensitizers and neutron therapy is introduced. Survival rates for all brain tumor cases treated in this Department are 81.3% for 1-yr, 72.3% for 2-yr, 60.8% for 4-yr, and 54.9% for 5-yr survivals. The survival rates for brain tumors (mostly glioma) other than pituitary tumors are 69.4% for 1-yr, 54.8% for 2-yr, 50.6% or 3-yr, 41.0% for 4-yr, and 32.3% for 5-yr survivals. Survival rate is highest for pituitary tumors among all brain tumors, being 185 out of 530 cases, or 34.7%. This rate was 11% in this Department, showing that radiotherapy was not indicated for gliomas. Gliomas in the cerebral hemisphere, such as pinealoma, ependymoma, and meningioma, are given postoperative radiotherapy. Pons and pontocerebellar tumors, and infantile brain tumor among cerebellar tumors are given 4000 to 5000 rad irradiation. Irrespective of the radiation dose, prognosis is poor, the survival rate being 40.8% after 6 months and 22.2% after 1 yr. In pituitary adenoma, recurrence was 9% in cases given radiotherapy with surgery and 31.2% in cases with surgery alone. Treatment of acromegaly with radiation was checked by the use of growth hormone as an indicator and the effect varied, indicating that treatment of acromegaly with radiation alone should be reexamined. (Japan)

9598 EXTRACORPOREAL IRRADIATION OF BLOOD AND LYMPH. Chertkov, I. L.; Agranenko, V. A. (Central Inst. of Haematology and Blood Transfusion, Moscow). At. Energy Rev.: 9: No. 3, 487-545(1971).

The problem of extracorporeal irradiation of blood and lymph in experiments and in the clinic is considered. The irradiation methods and equipment developed so far and the mathematical methods of determining the probability of irradiating different categories of cells, etc. are described. The data on the effect of extracorporeal irradiation on lymphocytes and lymphoid tissue in general and on the transplantation immunity reaction are analyzed. Data are given on clinical trials of extracorporeal irradiation for the treatment of different types of malignant blood diseases. The significance of the data obtained, from the point of view of understanding the histogenesis of lymphocytes, the kinetics of different populations of lymphoid and malignant cells, the mechanisms by which the levels of these cells in blood and tissues are regulated, etc., is discussed. The prospects of further research in this field are considered. (auth)

9599 TREATMENT OF HYPERTHYROIDISM IN GRAVES' DISEASE WITH SMALL DOSES OF RADIOACTIVE IODINE. Wils, J. A. (St. Radboudziekenhuis, Nijmegen, Netherlands); Kloppenborg, P. W. C. Ned. Tijdschr. Geneesk.; 115: No. 15, 657-62(10 Apr 1971). (In Dutch).

The results of the treatment of hyperthyroidism in Graves' disease with very small doses of radioactive iodine followed by a period of treatment with thyreostatic agents were studied in a group of 48 patients, 43 of whom either failed to respond to a treatment with thyreostatic agents alone, or presented persistent hyperthyroidism after subtotal thyroidectomy. All the patients were given ^{131}I in a dose of 2 mC, followed by a treatment with 40 mg. methimazole and 75 μg triiodothyronine daily. After 6 months, on the basis of an ^{131}I uptake examination, performed after stopping methimazole for 48 hours while continuing triiodothyronine, it was decided either to discontinue the administration of the drugs, or to administer a second dose of 2 mC of ^{131}I. This procedure was repeated 6 months after the second dose of ^{131}I. Six months after the first dose of ^{131}I, the treatment with thyreostatic agents was discontinued in 21 patients, while of the 27 patients who were given a second dose, this treatment was stopped six months after the second dose in 11 cases. All these 32 patients remained euthyroid during a follow-up period of at least one year after the last dose of ^{131}I. It is concluded that the treatment with small doses of ^{131}I gives results that cannot be obtained with thyreostatic agents alone, and that the risk of post-therapeutic myxoedema is also reduced. (auth) (Netherlands)

9600 DIAGNOSIS AND THERAPY OF THE SOCALLED TOXIC ADENOMA OF THE THYROID. Uthgenannt, H.; Adlung, J.; Brinkhoff, H. (Medizinische Akademie, Luebeck). Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 3, 340-7(Sep 1971). (In German).

The concept of toxic adenomas is controversial. In most cases, peripheral metabolism is that of the euthyroid state. It is considered more appropriate to talk of autonomous adenomas with a euthyroid or hyperthyroid state. During a period of ten years, 209 such cases were observed. Follow-up results of 118 treated patients are presented. Surgery has a number of advantages over radioiodine treatment. In recent years, surgical treatment was increasingly used. (auth)

9601 RADIOTHERAPY RESULTS OF NEUROBLASTOMAS (SYMPATHOGONIOMAS): EXPERIENCE AT ZURICH FROM 1938 TO 1970. Kaestner, W.; Woellgens, P. (Univ., Zurich. Poliklinik fuer Radiotherapie und Nuklearmedizin, Zurich).

Fortschr. Geb. Roentgenstr. Nuklearmed.; 115: No. 3, 386-90 (Sep 1971). (In German).

Between 1938 and 1970, 34 patients with sympathogoniomas were treated at the Zurich university hospital. Of these patients, 35% survived without recurrences or metastases during the observation time of 4 to 26 years. Cure rate was higher for younger patients than for older ones. When tumor cells were found in the bone marrow, the prognosis was poor. With respect to treatment, the following survival rates were obtained: radical surgery followed by radiotherapy 100%; incomplete tumor resection followed by radiotherapy 57%; and radiotherapy alone in patients with liver metastases 58%. (tr-auth)

Blast and Thermal Effects

Refer also to abstract 9496.

Radiation Effects on Animals

9602 CONSTANCY OF BIOLOGICAL PARAMETERS IN A 14 MeV NEUTRON FIELD. Nias, A. H. W.; Greene, D.; Major, D. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 20: No. 2, 145-51(1971).

HeLa cells were irradiated at various points in a collimated beam of 14 MeV neutrons from a D-T generator. RBE values varied slightly between the surface and 10 cm depth in water and also at the penumbra. Oxygen enhancement ratio values remained constant. No recovery from sub-lethal damage was found. (auth)

9603 SPONTANEOUS AND X-RAY-INDUCED GENOTYPIC AND PHENOTYPIC RESISTANCE TO 5-IODO-2'-DEOXYURIDINE IN LYMPHOMA CELLS IN VITRO. Fox, Margaret (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Mutat. Res.; 13: No. 4, 403-19(Dec 1971).

The survival curve of P388 cells plated in 5-iodo-2'-deoxyuridine (IUdR) shows an exponential decline at low doses followed by a plateau with little further reduction in survival after doses from $5.6 \cdot 10^{-5}$ to $2.8 \cdot 10^{-4}$ M. X-irradiation of cultures prior to plating in a range of IUdR concentrations resulted in an increased frequency of resistant colonies at all doses of x-rays and all concentrations of IUdR. Surviving colonies both in control and irradiated populations were tested for heritable resistance to IUdR. After selective doses of $2.8 \cdot 10^{-5}$ M or less, no heritable resistance could be demonstrated. It is suggested that x-rays can induce phenotypic resistance to IUdR. When higher selective concentrations of IUdR were used, an increase in true mutations after x-irradiation was detected. There was a linear relationship between inoculum size and frequency of IUdR-resistant colonies, and greater numbers of both phenotypically and genotypically resistant colonies were recovered when cells were incubated for 24 h before plating than when cultures were plated in selective medium immediately after irradiation. Forward heritable mutation to IUdR resistance occurred at a rate of $1.1 \cdot 10^{-7}$–$4.3 \cdot 10^{-6}$/locus/rad. The spontaneous and x-ray-induced reversion frequency from IUdR resistance to IUdR sensitivity was also measured and was found to occur at a much lower rate than forward mutation to IUdR resistance, ranging between $2.0 \cdot 10^{-8}$/locus/rad and $2.1 \cdot 10^{-7}$/locus/rad. The possible mechanism of the observed phenotypic resistance is discussed. (auth)

9604 SEPARATION AND IN VITRO GROWTH OF MAMMALIAN CORNEAL EPITHELIAL AND ENDOTHELIAL CELLS. Ellingson, D. J.; Yao, K. T. S. (Public Health Service, Rockville, Md.). Exp. Cell Res.; 66: 478-82(Jun 1971).

A double Rose chamber technique is described for simultaneously separating the endothelial and epithelial cells from the corneas of a variety of animals. Endothelial cells, although few in number at harvest, quickly grew into thriving cultures. Epithelial cells, although obtained in large numbers from the corneas, were more difficult to establish and grow. These two types of cells from one tissue differ greatly in culture and are useful materials for various comparative studies. Cells from x-irradiated animals produced multinucleated giant cells and abnormal fibroblastic cells. (auth)

Invertebrates

9605 ULTRAVIOLET IRRADIATION STUDIES WITH TRYPANOSOMA CRUZI. Centanni, Russell Joseph. Missoula, Mont.; Univ. of Montana (1971). 144p. University Microfilms Order No. 71-28,061.

Thesis.

One of the most fundamental research problems in biology is the study of the effects of irradiation on living cellular systems. Irradiation may damage cells, mutate cells, morphologically alter cells, and kill cells. Virtually no data exist on the effects of ultraviolet (uv) radiation on parasitic protozoa. Therefore, a general study of the effects of uv-irradiation upon Trypanosoma cruzi, the etiologic agent of Chagas' Disease, was undertaken. Culture forms of T. cruzi were exposed to various doses of uv light (λ 2537 Å). The effects of uv light upon the growth and survival of irradiated trypanosomes were examined. Aspects of protection and reactivation from irradiation were studied. Also, the influence of uv radiation on the dehydrogenase activity of T. cruzi was investigated. Trypanosoma cruzi was sensitive to uv radiation. A reciprocal relationship existed between survival and uv dosage. Log phase organisms were more sensitive to radiation than organisms harvested during the stationary phase. Trypanosoma cruzi was protected from the lethal effects of uv radiation by: preirradiation incubation at 5°C and 37°C; preirradiation starvation for 12 to 48 hours; preirradiation illumination with white light (photoprotection); and irradiation in the presence of nucleic acid derivatives or aromatic amino acids. Post-irradiation incubation at 5°C; and exposure to visible light (photoreactivation) emitting wavelengths below 520 nanometers, induced recovery in irradiated trypanosomes. Ultraviolet irradiation stimulated the dehydrogenase activity of T. cruzi when glucose was used as the substrate. In contrast, an inhibition of succinic dehydrogenase activity occurred in irradiated trypanosomes. Since there are no published data on the effects of uv radiation on T. cruzi, this is the first and only research that has been conducted in this area. The data demonstrated that T. cruzi was sensitive to uv radiation. The degree of sensitivity depended on the age of the culture and the metabolic state of the organisms. Pre- and post-irradiation treatments which induced suboptimal growth conditions protected T. cruzi from uv-irradiation. Photoreactivation of irradiated T. cruzi indicated that this organism possesses the necessary enzyme system to complex with and repair the uv-induced damage. (Diss. Abstr. Int., B)

9606 PROMPT RESPONSES OF THE SEA URCHIN, STRONGYLOCENTROTUS PURPURATUS, TO IONIZING RADIATION. Dedrick, Millridge Cornelius. Corvallis, Oreg.; Oregon State Univ. (1971). 100p. University Microfilms Order No. 71-25,063.

Thesis.

The behavioral reactions of the purple sea urchin, Strongylocentrotus purpuratus, to 300 kVp x-rays were studied. Also, a study was made of the lethal response to the same conditions of exposure in order to provide a basis for estimating the sensitivity of the behavioral responses. The urchin was found to detect small bursts of x-rays and exhibited this detection by distinct behavioral responses. These responses were retraction of tubefeet, flexion of the spines, and a general excitability as shown in increased movement. When the intact urchin was exposed to x-rays at exposure rates of 1 R/sec to 15 R/sec until a response occurred, it exhibited both tubefoot retraction and spinal flexion. Under continuous exposure, reaction time for tubefoot retraction was exposure-rate dependent and varied from 1.9 seconds at 15 R/sec to 12.5 seconds at 1 R/sec. The reaction time for spinal flexion was also exposure-rate dependent and varied from 96 seconds at 15 R/sec to 162 seconds at 1 R/sec. The minimum amount of exposure required to elicit a response at 1 R/sec was found to be 2 R for tubefoot retraction and 6 R for spinal flexion. Both the reaction of the spines and of the tubefeet were found to be affected by intense light, suggesting the possibility that photoreceptors were perhaps a site for detection of x-rays by the urchin. The photoreceptors are not entirely responsible for the response, however, since isolated tubefeet showed some response in intense light. The sea urchin is relatively resistant to x-ray as shown by its $LD_{50/60}$ days of 10.37 kR. The urchins appear to die with only one syndrome since survival times for decedent animals were narrowly distributed for a given amount of exposure. This syndrome was not studied in detail. The acute phase of radiation injury for the urchin appeared to last about eight weeks. Those that survived this period recovered from the acute effects. (Diss. Abstr. Int., B)

9607 EFFECTS OF GAMMA RADIATION ON THE REPRODUCTION OF THE ALFALFA WEEVIL HYPERA POSTICA (GYLLENHAL) (COLEOPTERA: CURCULIONIDAE). Ferrer, Francisco Ramon. University Park, Pa.; Pennsylvania State Univ. (1971). 160p. University Microfilms Order No. 71-28,685.

Thesis.

Studies were undertaken to determine the effect of gamma radiation on the reproduction of the alfalfa weevil Hypera postica (Gyllenhal). Cobalt-60 was the source of gamma radiation. Two, three, four, and five-week old male weevils were irradiated with 2,500 to 4,500 R gamma radiation. Matings of irradiated males and non-irradiated females demonstrated that doses higher than 3,500 R induced complete sterility in three and four-week old male weevils over a three-month period of oviposition. Females irradiated when three and four weeks old were more resistant to

sterility than similarly aged males. These females evidenced about 32 and 15 per cent fertility, respectively, after being irradiated with 3,500 R and mated with non-irradiated males. A dose of 4,500 R was needed to completely sterilize these females. Irradiation of the males alone as in a non-irradiated female-irradiated male combination (N♀ x I♂) was as effective in reducing fertility as irradiating both females and males, as in a I♀ x I♂ combination, and more effective, when using similar doses, than irradiating only females, as in I♀ x N♂ mating pairs. Irradiated females were less fecund than non-irradiated females. Doses above 4,500 R caused almost a complete cessation of egg production. Only five per cent of those eggs laid by females irradiated with 3,000 R and mated with non-irradiated males, developed to the adult stage. None of the eggs laid by females irradiated with 3,500 R and similarly mated developed to adults. Mating competitiveness as well as the capability to transfer sperm was not diminished in irradiated males. Those males that received 3,500 R at four weeks of age mated successfully at seven and eight weeks of age and transferred competitive spermatozoa. Survival of males irradiated at two to five weeks of age essentially was not affected by the doses employed even when these doses were as high as 4,500 R. Females likewise were not affected during 90 days post-irradiation except, by a dose of 4,500 R applied to three-week old females in which case 100 per cent mortality occurred. Doses of 25,730 to 44,900 were required to induce 50 per cent mortality seven days after irradiating field-collected weevils. Mortality followed a sigmoidal curve over the time of observations, especially for doses of 50 and 75 Kr gamma radiation. The present study suggests that radiation sterilization might be employed to control alfalfa weevil populations. Several characteristics which are required to initiate a successful autocidal program have been demonstrated, and have shown sufficient promise to warrant further investigations. (Diss. Abstr. Int., B)

9608 EFFECTS OF GAMMA RADIATION AND TEMPERATURE ON THE BIOLOGICAL ASSIMILATION AND RETENTION OF ^{137}Cs BY ACHETA DOMESTICUS (L). van Hook, Robert I. Jr.; Herbert, Elizabeth T. (Oak Ridge National Lab., Tenn.). Health Phys.; 21: No. 6, 845-50(Dec 1971).

Cesium-137 retention was determined for brown crickets, Acheta domesticus, irradiated with 0, 1000, 2500, and 5000 rad γ radiation and maintained at 20, 25, and 30°C. Parameters examined for temperature and dose effects were per cent ^{137}Cs assimilated into body tissues (p_2), rate of isotope passage through the gut (k_1), and rate of elimination of assimilated ^{137}Cs (k_2). Increases in temperature and γ dose resulted in a general decrease in per cent ^{137}Cs assimilated per day (p_2). The first-component elimination coefficient (k_1) was not significantly affected ($P \leq 0.05$) by either temperature or dose changes. Biological elimination coefficients for assimilated ^{137}Cs (k_2) increased with increasing temperature between doses of 0 and 2500 rad. Above 2500 rads however, increases in temperature had no noticeable effects on the rate of assimilated ^{137}Cs excretion. At higher dose levels, radiation was the dominant factor influencing the parameter k_2. (auth)

Vertebrates

Refer also to abstracts 9459, 9470, 9472, 9474, 9477, 9478, 9498, 9500, 9542, 9561, 9562, 9566, and 9569–9571.

9609 (LF-tr-67) INVESTIGATIONS ON THE PATHOGENESIS OF RADIOPNEUMONITIS. Dippell, J.; Lissner, J.; Antaszak, C. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Strahlentherapie; 141: 135-40(1971). 9p. Dep. NTIS.

In an earlier publication the authors arrived at the conjecture that during the genesis of the radiation syndrome there takes place in the lungs, under certain conditions, immunomechanical phenomenon. There was found in rabbits, which were exposed to a unilateral single high dose irradiation of the lung (4000 to 6000 rad γ radiation), after a latent period of two to three weeks, a drop of the total complement content of the serum, as well as a reaction also in the nonirradiated lung, in the sense of an interstitial pneumonitis. In a further experimental series, we have checked these data, and have extended the method by means of fluorescent-histological investigations. (auth)

9610 ACUTE DEATH AFTER IRRADIATION OF SINGLE 60-MeV ELECTRONS. Sakka, Masotoshi; Sasaki, Shunsaku; Inomata, Tsuyako (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 6, 566-8(Sep 1970). (In Japanese).

Acute death following a single irradiation of ^{60}MeV electrons produced by the linear accelerator of Tohoku University was observed for rodents and frogs. Dosimetry was made by means of the electric current produced in the irradiated lead block. The mean duration of survival time was very short in mice when they were irradiated totally or to the head (4.8 hours after irradiation of 50 μCi and 98 seconds after irradiation of 500 μCi). Dosimetric technique, the 60 to 110 min effect in the survival curves, and etiology of rapid death are the important and difficult problems. (Japan)

9611 RADIOINDUCED CHROMOSOME ABERRATIONS AND LYMPHOCYTE KINETICS. Sugahara, Tsutomu (Kyoto Univ.). Radioisotopes (Tokyo); 20: No. 7, 340-8(Jul 1971). (In Japanese).

The study of the mechanism to induce chromosome aberrations has not gone beyond a hypothesis. In this regard, the present report outlines the studies on the perpetuity of chromosome aberrations elucidated since the establishment of the method for examination of the chromosome by Moorhead. The general consideration on chromosome aberrations is limited to the introduction of representative general remarks. The form of chromosome aberrations differs by the cycle of cells irradiated. Chromosome aberrations include not only abnormalities in the shape of individual chromosomes but those in the number of chromosomes. These abnormalities are divided into the stable ones that are inherited by the following generation and the labile ones that disappear. The method used by Moorhead revealed that labile-type chromosome aberrations were observed in high frequency in the peripheral lymphocytes of humans after irradiation. It was clarified also that the perpetuity of chromosome aberrations was involved in the life of cells. Abnormalities in the peripheral lymphocytes are caused also by the treatment of malignant tumors by radiation, and the application of radioprotective substances to the human body has been started. Similar abnormalities are produced also by chemical compounds such as anticancer drugs, but disappear quickly in such a case. Recently, the method for examining the chromosome by culture of the peripheral blood was improved, but the cellular kinetics of experimental animals differs from that of humans in which cells with abnormalities due to radiation disappear rapidly. The labeling method with ^{3}H-thymidine has revealed the presence of long-life lymphocytes, and it is known that only the rhesus monkey shows the kinetics of peripheral lymphocytes similar to that of humans. (Japan)

9612 EXPERIMENTAL STUDY OF ACUTE RENAL INJURY CAUSED BY A SINGLE WHOLE-BODY IRRADIATION WITH GAMMA RAYS AT A LARGE DOSE LEVEL. Sohtome, Shigeru (Nihon Univ., Tokyo). Nichidai Igaku Zasshi; 29: No. 11, 1007-17(Nov 1970). (In Japanese).

The study was conducted to determine if whole-body irradiation with large doses of γ rays would induce uremia by an acute renal injury. To clarify the pathogenesis of the nephropathy, rabbits were given a single exposure to γ rays at either 500 or 1000 R. The examinations involved measurement of intrarenal territorial blood flow, biochemical analysis, and histological studies carried out chronologically. Commencing from 1 to 14 days after irradiation, three phases were postulated in the post-radiation course: the first lasting 3 days, the second 4 to 9 days, and the third that after 10 days. In the first stage, decreased cortical blood flow was recorded. This developed into cortical hyperemia in the following two phases. In the first two phases, elevated serum NPN (near 50 mg/dl) and K (over 5 mEq/l) were noted. Histology revealed marked hyperemia in the zone of the corticomedullary junction. There were foci of desquamated epithelial cells clumping in the lumen of Henle's loop and distal convoluted tubule. Pycnotic nuclei of the endothelial cell of the peritubular capillary in the medulla were also noticed. In the third phase, the blood flow was restored with remission of the cortical hyperemia. The serum NPN still remained above the normal level. There was definite regeneration of capillary endothelial cells characterized by the presence of aggregated, hyperchromatic nuclei showing occasional mitosis. (auth) (Japan)

9613 PULMONARY ALVEOLAR SURFACTANT IN IRRADIATED LUNG OF RAT. Oikawa, Masaru (Iwate Medical Coll., Morioka, Japan). Tohoku J. Exp. Med.; 102: No. 3, 265-72(Nov 1970).

Male rats of the Wistar strain, weighing 250 to 350 g, were given x radiation doses of 5,000 R and 7,000 R, respectively, to their right lungs. Samples were taken from nonirradiated areas (left lung) and atelectatic areas of irradiated lung. Histologic sections were made and alveolar sac stability was estimated. The data were compared with those of control rats. The results indicate that following irradiation the atelectatic areas show decreased alveolar sac stability ratios that suggest the diminution of alveolar lining surface-active material. (auth)

9614 AUTORADIOGRAPHIC STUDY OF THE EFFECT OF X RAYS ON DNA AND RNA SYNTHESIS DURING SEGMENTATION AND GASTRULATION OF PLEURODELES WALTLII. Alexandre, Hanri (Univ. Libre, Brussels). Arch. Biol. (Liege); 81: No. 1, 139-62(1970). (In French).

Young embryos of the amphibian, Pleurodeles waltlii, were given various doses of x radiation. Tritium tracer studies were then conducted on morphogenesis and synthesis of DNA and RNA. It was found that x rays applied to cleaving eggs inhibited DNA replication and mRNA synthesis in proportion to the dose and development of the advanced blastula stage was inhibited. The lower level of radiosensitivity observed in gastrulas resulted in a higher resistance to x rays of the synthesis of DNA from thymidine; the metabolic pathway whereby DNA is synthesized by incorporation of uridine was very much altered by irradiation. (H.L.W.)

9615 RAT HEART ALLOGRAFT SURVIVAL WITH DONOR PRETREATMENT. Freeman, Jan S.; Chamberlain, E.; Reemtsma, Keith; Steinmuller, David (Univ. of Utah, Salt Lake City). Circulation, Suppl.; 43 and 44: No. 1, I.120-3(May 1971).

Heterotopic rat heart transplants from Ag–B compatible Fischer strain donors to Lewis recipients were monitored by daily ECG. The median survival time (MST) of control grafts was 12.8 days. Pretreatment of donors with whole-body radiation, cyclophosphamide, or antilymphocyte serum resulted in MST of 19.7, 18.0, and 17.8 days, respectively. Local irradiation of the heart alone did not prolong survival beyond control values, whereas whole-body irradiation with the heart shielded did, indicating that the prolongation achieved by donor pretreatment with radiation, at least, was a systemic rather than local effect. Only slight prolongation was achieved by donor radiation in the Ag–B incompatible BN to Lewis strain combination, demonstrating the importance of histocompatibility matching for the effectiveness of donor pretreatment. (auth)

9616 REGENERATION OF THE LOCALLY IRRADIATED BONE MARROW IN POLYCYTHEMIC RATS. Ninkov, Vukosava; Stepanovic, Dusanka (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie; 142: No. 1, 105-11(Jul 1971).

Postirradiation recovery of the bone marrow in locally irradiated normal and polycythemic rats has been studied, one limb having been exposed to 800 R. Polycythemia was produced by hypertransfusion of erythrocytes and maintained throughout the experimentation. Peripheral blood and bone marrow were studied subsequently. Regeneration in irradiated polycythemic rats was found to re-establish mitotic activity of RBC precursors in the same way and for the same interval of time as in the non-plethoric irradiated controls. It seems that the changes produced by local irradiation of the bone marrow resulted in conditions such that erythroid cell production in plethoric rats regenerated in the same way as in non-plethoric rats in spite of general body plethora. (auth)

9617 HUMORAL FACTORS AND METABOLIC PROCESSES INFLUENCING THE RADIORESISTANCE OF THE GROUND SQUIRREL (CITELLUS CITELLUS) IN HIBERNATION. Rusev, G.; Stefanov, St.; Radev, S.; Penkov, V. (Radiobiology Lab., Sofia). God. Sofii. Univ., Biol. Fak.; 63: No. 1, 251-66(1968-69). (In Bulgarian).

Studies were conducted on the effects of x radiation on oxidation processes and formation of stable organic peroxides in tissues of ground squirrels in January (during hibernation) and in June. Extracts from the pituitary, hypothalamus, and brain, as well as blood catecholamines and a new L factor from brown lipid tissue were isolated from ground squirrels in hibernation and from laboratory hamsters for determining their effects on radioresistance. Active and hibernating ground squirrels reacted to x radiation with accelerated oxidation processes. The acceleration was weaker in hibernating animals due to the changed hypothalamic regulation and to the presence of a greater quantity of antioxidants. Radioresistance of ground squirrels in hibernation is due to metabolites in the brown lipid tissue which disappear in active animals. (H.L.W.)

9618 EFFECTS OF SUPRALETHAL GAMMA RAY DOSES ON SURVIVAL TIME AND CERTAIN BLOOD PARAMETERS OF NORMAL, ACATALASEMIC, AND AMINOTRIAZOLE-TREATED MICE. Feinstein, R. N.; Nelson, D. M. (Argonne National Lab., Ill.). Kerntech. Atomprax.; 13: No. 9, 400-2(Sep 1971).

Normal and acatalasemic (blood catalase about 1% of normal) mice received 25, 50, or 75 kR of ^{60}Co γ radiation. Survival time of the acatalasemic mice was shorter than that of normal animals. Plasma protein of both groups, but particularly of the acatalasemic animals, was reduced. Heme pigment, particularly of the acatalasemic animals, was increased. Per cent methemoglobin was not significantly changed, but there was a consistent tendency for increased methemoglobinemia in acatalasemic mice. Hematocrit values were sharply affected, depending on strain, radiation dose, and sampling time after radiation; hematocrits over 70% were observed in some instances. (auth)

9619 EFFECTS OF EARLY PREOVULATORY GAMMA IRRADIATION AND EXOGENOUS GONADOTROPINS OF SUBSEQUENT FETAL DEVELOPMENT IN MICE. Zilles, Connie Lauren Buchanan. Boston; Boston Univ. (1971). 102p. University Microfilms Order No. 71-26,503.

Thesis.

Both experimental studies on animals and limited clinical evidence from humans have shown that ionizing radiation administered shortly before ovulation adversely effects subsequent fetal development. There are however a number of questions which remained to be elucidated: Are there persistent chromosomal aberrations in the ova over an extended irradiation to ovulation interval? Does the use of exogenous gonadotropins in any way effect the radiosensitivity of the oocytes? How much can the irradiation to ovulation interval be extended? The second of these questions being of some importance in interpreting earlier experimental work since many investigators had used exogenous gonadotropins to induce timed ovulations. Chromosomal aberrations were found in fertilized ova after gamma irradiation of the ovarian oocytes with 450R. Gross abnormalities were observed in late anaphase II in the form of stray chromatids, pieces of chromatids, undivided chromatid pairs, and possible broken bridges. Aberrations were not observed in the control group. A statistically significant increase in preimplantation and postimplantation lethality was found following hormonal induction of ovulation as compared with sham-injected controls. When irradiation was combined with the hormonal treatment, it was observed that the hormonal treatment obscured the true evaluation of the radiation-induced lethality. The chromosomal aberrations seen were of the type observed following irradiation of later oocyte stages and ovulated ova. This study provides evidence that irradiation occurring much earlier can result in the ovulation of ova carrying chromosomal damage. The data from the gonadotropin experiments strongly suggests that exogenous gonadotropins should not be used if an accurate estimate of radiation damage is desired. Furthermore, since the mechanism of damage is not known, any use of these hormones is subject to criticism. (Diss. Abstr. Int., B)

9620 LATE PATHOMORPHOLOGIC CHANGES IN THE ADRENALS OF FEMALE MICE IRRADIATED WITH ^{60}Co ON THE FIRST DAY OF LIFE. Chomiczewski, K. (Military Medical Academy, Lodz, Poland). Folia Biol. (Krakow); 19: No. 3, 429-36(1971).

Irradiation of mice of the A strain on the first day of life with sublethal doses of ionizing radiation from a ^{60}Co point source caused late morphologic changes in the adrenals. The changes consisted in atrophy of all the cortical zones and parts of the medulla without signs of compensatory regeneration. Diminished content of RNA in the cells of the zona fasciculata and increased numbers of B cells indicate inhibited synthesis of steroid hormones. The morphologic changes in the beta cells of the anterior lobe of the hypophysis were correlated with damage of the adrenocortical cells. The degree of damage of the adrenocortical cells was proportional to the dose of irradiation up to 300 R. Doses of 450 R produced no further statistically significant morphologic changes. The observed changes resembled the aging process in mice, but differed in the absence of regeneration. (auth)

9621 UV-INDUCED INCREASE IN NUMBER OF PERIVENTRICULAR GOMORI-POSITIVE GLIAL CELLS IN BRAINS OF MICE. Srebro, Z.; Lach, H. (Inst. of Biomorphology, Krakow. Teacher Training Coll., Krakow). Experientia; 27: No. 9, 1075-6(15 Sep 1971).

Fifty female mice were divided into four experimental and one control group, each consisting of ten individuals. Ultraviolet irradiation was administered for 30 min on each consecutive day. Animals of the first experimental group were irradiated for 7 days, the second group for 14 days, the third for 21 days, and the fourth for 28 days. After the animals were killed, the brains were fixed and stained and the Gomori-positive periventricular glial cells were counted around the anterior part of the third brain ventricle. The radiation caused a marked increase in the number of Gomori-positive cells in animals killed after 14, 21, and 28 days of irradiation. The amount of Gomori-positive granules in individual cells was also much greater in the irradiated animals than in the controls. (H.L.W.)

9622 COURSE OF HEALING AND TRANSFORMATION OF A BONE CHIP IRRADIATED WITH FAST ELECTRONS. Horn, V.; Blaha, J.; Slechta, J. (J. E. Purkyne Univ., Brno). Z. Orthop. Ihre Grenzgeb.; 109: 291-301(May 1971). (In German).

Alloplastic chips of compact bone were irradiated with various high doses in the betatron and implanted into the femurs of rats, along with a chip of normal autologous bone as control. The healing and catabolism of the chips were then evaluated at different periods by histological and enzymatic histochemical methods. The

catabolism of the irradiated alloplastic chips was found to be quicker than that of the autologous control chips. The results obtained are considered to be a positive contribution to the work of tissue centers and all places which are concerned in the transplantation of bone chips. (auth)

9623 INVESTIGATION OF ADENYLIC NUCLEOTIDE CONTENT IN RAT MYOCARDIUM AFTER WHOLE-BODY AND LOCAL IRRADIATION BY RADIOACTIVE COBALT. Vorob'ev, E. I.; Fomina, E. V.; Khanson, K. P. (Central Scientific-Research Roentgeno-Radiological Inst., Leningrad). Vop. Med. Khim.; 17: No. 5, 484-8(Sep-Oct 1971). (In Russian).

An investigation was made of quantitative content of adenylic system components in cardiac muscle of rats after total (in a dose of 1000 rad) and local (in a dose of 2400 rad) γ-irradiation. Concentration of adenylic nucleotides was measured 1, 6, 24 and 72 hrs after whole-body irradiation as well as in shorter (less than 1 hr) and longer periods (7, 14, 30 and 45 hrs) after local irradiation. The experiments all indicate that γ-irradiation does not result in repression of mechanisms involved in production of high-energy phosphates (ATP concentration persists at a rather high level). At earlier stages after irradiation (less than 1 hr) there occurs a substantial increase in ATP concentration and nucleotide content in myocardium. A single physical stress induces a decrease in ATP content and a sharp fall of ATP/ADP ratio in non-irradiated animals; while being applied right after local irradiation, physical stress does not affect the above parameters. Thus additional influence demonstrates changes in the processes of energy supply for contractile activity of cardiac muscle as manifested apparently by a repression of ATP utilization. (auth)

9624 EFFECTS OF HYPOXIC HYPOTHERMIA ON THE EARLY HISTOLOGICAL CHANGES IN THE SPLEEN AND THYMUS OF IRRADIATED MICE. Mackova, N.; Praslicka, M.; Misurova, E. (Safarik Univ., Kosice, Czech.). Biologia (Bratislava); 26: No. 3, 249-56(1971). (In Slovak).

The effect was studied of hypoxic hypothermia and of ionizing radiation on the development of histological changes in the spleen and thymus of mice. The histological changes resulting from ionizing radiation were found to correspond to the data published in the literature. Hypoxic hypothermia following irradiation resulted in the shift of time of destructive changes in the two organs and in a slightly increased erythroid tissue in the red pulp of the spleen. This, however, disappeared by the 5th day. A long-term hypoxic hypothermia was found to result in slightly damaged lymphoid tissues of the spleen and thymus and in a distinct stimulation of ectopic erythropoiesis in the spleen. These changes were found to be of a temporary character. On the 5th day, the spleen and the thymus were observed to regain their normal appearance. (NSA of Czech)

9625 BLOOD FLOW AND VOLUME MEASUREMENTS IN THE RADIATION DEPOPULATED TESTIS OF THE RAT. Jones, T. (Hammersmith Hospital, London). Brit. J. Radiol.; 44: No. 527, 841-9(Nov 1971).

The testis of the rat was used as an experimental model for measuring blood flow and blood volume changes in tissue depopulated by x-rays. For single doses of x-ray up to 600 rads, the blood flow per unit weight remained constant during the depopulation phase, while the blood volume per unit weight of tissue was increased. (auth)

9626 ANEMIC STRESS AS A TRIGGER OF MYELOGENOUS LEUKEMIA IN RATS RENDERED LEUKEMIA-PRONE BY X-RAYS. Gong, Joseph K. (State Univ. of New York, Buffalo). Science; 174: No. 4011, 833-5(19 Nov 1971).

All of the 128 Sprague-Dawley female rats bled two-thirds of the blood volume at one, two, or three months after x irradiation (50, 170, or 350 roentgens) succumbed to leukemia by 16 months after bleeding. Some nonbled irradiated rats developed leukemia possibly as a result of triggering by a radiation-induced anemia. The threshold leukemogenic x ray dose is probably below 25 roentgens. Elevated levels of basophils, neutrophils containing the pseudo-Pelger type nuclear–anomaly, and myeloblasts exhibiting Auer rods seen in these animals were generally not found in earlier models of rat myelogenous leukemia. (auth)

9627 INVESTIGATIONS ON THE CATHEPTIC ACTIVITY OF LIVER IN IRRADIATED RATS. Kocmierska-Grodzka, D.; Goutier, R. (CEN-SCK, Mol, Belg.). Strahlentherapie; 142: No. 3, 345-8(Sep 1971).

Cathepsin B activity was measured in the lysosomal and in the soluble fractions of livers from rats irradiated on the whole body with 800 R 24 hours before sacrificed. The catheptic activity was found to be increased in the lysosome fraction and slightly decreased in the soluble supernatant fraction. When incubated at 37°C in vitro, lysosomes from irradiated livers released more catheptic activity than the controls into incubating medium and also displayed a greater permeability to the substrate of cathepsin B used. (auth)

9628 EFFECT OF A CORTICOID ON THE RADIOINDUCED INHIBITION OF MITOSIS. Kaufmann, Horst; Kottmann, Friedhelm (Ruhr-Univ., Bochum, Ger.). Strahlentherapie; 142: No. 3, 340-4(Sep 1971). (In German).

The course of the radiation-induced inhibition of mitosis of Ehrlich–Ascites tumors in white mice was observed. The radiation dose was 250 rd; additionally 6-methylprednisolone was applied. It was observed that urbason intraperitonally injected in concentration of 0.2 ml/animal alone does not effect a change of the rate of mitosis, but the radiation-induced inhibition of mitosis is prolonged by urbason. This effect might be caused by enforced inhibition of the DNA synthesis. According to results of other investigators, the radiation-conditioned inhibition of the thymidine integration by corticoid is accompanied by inhibition of the uridine integration. (auth)

9629 QUANTITATIVE STUDIES OF HISTONES AND DNA IN THE MOTONEURONS OF THE SPINAL CORD OF MICE AFTER TOTAL-BODY GAMMA-IRRADIATION. Olkowski, Zbigniew; Manocha, Sohan L. (Emory Univ., Atlanta). Strahlentherapie; 142: No. 3, 365-70(Sep 1971).

Quantitative measurements on the amounts of DNA and histone were carried out on the motoneurons and spinal cord taken from normal healthy mice and those subjected to total-body gamma-irradiation of 600 R at the rate of 37.5 R/min/mice and 636 R at the rate of 53 R/min/mice at a distance of 50 cm. The irradiated animals were sacrificed at intervals of 2, 4, 8, and 12 hours. The histone/DNA ratio changed significantly, starting 4 hours after the irradiation procedure whereas the DNA value remained diploid in all groups of animals. The significance of decreased histone content after irradiation has been discussed. (auth)

9630 CYTOPLASMIC BUDDING OF LYMPHOID CELLS (CLASMATOSIS) AND HEMOPOIESIS IN IRRADIATED RATS. Kabakov, Y. N. (Research Inst. of Medical Radiology, Obninsk, USSR). Strahlentherapie; 142: No. 3, 371-5(Sep 1971).

Whole-body gamma irradiation in doses of 200, 400 and 600 R results at first in a decreased absolute content of the cytoplasmic fragments formed by clasmatosis in the spleen of Wistar rats and then in an increase in their number, which on the 12th day is inversely dependent on the dose and correlates (0.86 ± 0.05) with the absolute content of lymphocytes in the bone marrow of the tibiae. The kinetics of the relative content of the cytoplasmic fragments in the spleen, lymph nodes and thymus are very similar both at doses of 400 and 600 R, which is explained by the systemic character of the lymphoid tissue reaction to whole-body irradiation. The results are discussed from the point of view of the possible connection of clasmatosis in the reticuloendothelial system with cell alteration, differentiation and secretion of blood plasma globulins. (auth)

9631 COMPARATIVE ELECTROENCEPHALOGRAPHIC AND HISTOLOGIC STUDIES AFTER ROENTGEN IRRADIATION OF THE RABBIT BRAIN. Betetto, Milan (Dermatologische Univ., Ljubljana, Yugoslavia). Acta Med. Iugoslav.; 24: No. 4, 301-12(1970). (In German).

Methods for dosimetry of administering x radiation are described for experiments using ten male Chinchilla rabbits aged 6 to 8 months. Electrodes were placed in the frontal, occipital, and temporal lobes of the brain. Several electroencephalograms were taken before irradiation. Following irradiation, changes in frequency and amplitude occurred and figures are presented to show the normal EEG and the EEG 25 hrs after a 450 R dose of x radiation. Increased doses did not produce changes in frequency or amplitude. For histological studies, biopsies were made 28 days after irradiation. The minimum dose required to produce a change was 760 R and higher doses resulted in increased injury. Changes in cellular structure are described and illustrated. (H.L.W.)

9632 ANTIOXIDATIVE ACTIVITY AND RADIOSENSITIVITY OF NORMAL AND TUMOR TISSUES. Baglei, E. A.; Burlakova, E. B.; Dzyuba, N. M. (Inst. of Chemical Physics, Moscow). Tr. Mosk. Obshchest. Ispyt. Prir.; 32: 24-7(1970). (In Russian).

The antioxidative activity of lipids of some normal and tumor tissues with different degrees of radiosensitivity was investigated. It is shown that a certain correlation exists between radiosensitivity of pure strains of mice and the antioxidative activity of the liver lipids of these animals. It was found for the investigated rat sarcomas 45 and M–I that the radiosensitivity of the tumor is higher the lower the value of its antioxidative activity. (auth)

9633 EFFECTS OF X IRRADIATION TO GASTRIC REGION OF MICE WITH RESPECT TO INDUCTION OF GASTRIC ADENOCARCINOMA. Hirose, Fumio (Hiroshima Univ.). Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo; 10: 32-47 (May 1969). (In Japanese).

The gastric region of twenty-one 82 to 88-day-old CF_1 female mice in Group I was irradiated with 1,500 rads of x-ray at one-week intervals for a total of 6 exposures (total radiation dose of 9,000 rads) and of twenty-four 59-day-old CF_1 mice of both sexes in Group II with 2,000 rads of x-ray at one-week interval for a total of 5 exposures (total radiation dose of 10,000 rads). In Group I, 17 mice survived for more than 16 weeks after the initial irradiation, and mucosal atrophy of the glandular stomach was seen in 100% of the mice, ulceration in 88%, atypical hyperplasia (precancer) in 35%, and gastric adenocarcinoma in 12%. In Group II, 18 mice survived for more than 14 weeks after the initial irradiation, and mucosal atrophy of the glandular stomach was seen in 100% of the mice, ulceration in 78%, atypical hyperplasia (precancer) in 44%, gastric adenocarcinoma in 28%, and squamous cell carcinoma in 6%. A total of 7 cases of gastric adenocarcinoma was observed of which 2 had metastases to the pancreas or mesentery. (auth)

9634 GROWTH AND FECUNDITY OF RAINBOW TROUT (SALMO GAIRDNERI) EXPOSED TO SINGLE SUBLETHAL DOSES OF X RAYS DURING THE EYED EMBRYO STAGE. Welander, Arthur D. (Univ. of Washington, Seattle); Wadley, Gerald W.; Dysart, Douglas K.; (and others). J. Fish. Res. Board Can.; 28: No. 8, 1181-4(Aug 1971).

When rainbow trout (Salmo gairdneri) were reared for 2 years after irradiation with 21, 83, and 203 roentgens (R) during the eyed stage, the irradiation had no demonstrable effect on survival, growth, or fecundity. The trout were reared at temperatures of 15.4 and 17.2°C in parallel experiments for 160 days after fertilization. At the end of 2 years, 65 female trout (and 56 males), averaging more than 1400 g in weight, produced 186,400 eggs. Egg production was not related to irradiation dose or temperature; however, there was a slight dose-related increase in number surviving to the eyed stage in most of the irradiated groups. (auth)

9635 HISTOLOGICAL AND HISTOCHEMICAL STUDY OF THE CHANGES IN THE KIDNEYS AFTER AN EXPERIMENTAL FRACTIONATED LOCAL EXPOSURE TO X RAYS. Kovacs, Laszlo. Strahlentherapie; 142: No. 3, 331-9(Sep 1971). (In German).

Changes in the kidneys after a fractionated irradiation have been studied by histological and histochemical methods. In the course of the first 15 days after a total dose of 8000 R given in 16 fractions rather significant histochemical changes in addition to the structural changes were occurring. In the late phase, until the 150th day, the tubuli and the glomeruli are almost completely destroyed. There are no intensive cellular reactions, proliferation of connective tissue or regenerative symptoms following the slowly evolving process. (auth)

9636 EFFECT OF HYPERTRANSFUSION ON THE GROWTH OF MOUSE FOETAL LIVER CELLS TRANSPLANTED INTO IRRADIATED, ADULT RECIPIENTS: FAILURE TO DETECT A DIFFERENTIAL EFFECT BETWEEN CELLS FROM EARLY AND LATE FOETUSES. Tarbutt, R. G.; Cole, R. J. (Univ. of Sussex, Brighton, Eng.). J. Cell. Physiol.; 78: No. 2, 201-7 (Oct 1971).

Erythropoiesis can be reinstated in lethally irradiated mice by transplantation of adult bone marrow or liver cells from foetuses at any stage of gestation beyond the eleventh day. Hypertransfusion of the recipients abolishes erythropoiesis resulting from the transplants, even when the transplants are derived from foetuses at a very early stage of development. This suggests that erythropoietin is necessary for the successful growth of these early foetal transplants, at least in the environment of the irradiated recipient. These results are at variance with an earlier report on the susceptibility of early foetal liver transplants to suppression by hypertransfusion. (auth)

9637 RESPONSE OF RAT GASTROINTESTINAL TRACT PENTOSE CYCLE DEHYDROGENASE SYSTEMS TO WHOLE-BODY IONIZING IRRADIATION. Kivy-Rosenberg, Evelyn (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Int. J. Radiat. Biol.; 20: No. 4, 315-24(1971).

The activity of two dehydrogenase systems of the pentose cycle (glucose-6-phosphate-dependent and 6-phosphogluconate-dependent) was studied in homogenates of four regions of the adult male rat gastrointestinal tract following 1540 rads whole-body x-irradiation (WBR), or 1400 rads mixed gamma-neutron irradiation. Microchemical assays using a tetrazolium salt (INT) were done at intervals after irradiation (10–20 min, 1, 2, 3 days). By day 1 post-irradiation there was a significant fall in activity in both pentose cycle systems in the stomach. For the most part, the fall in activity did not occur in the intestinal regions until the second day. This depression became most prominent after 3 days for the regions studied. It appeared from this study that the dehydrogenase systems which are extramitochondrial showed a lesser depression in activity than did those previously reported as intramitochondrial. (auth)

Man

Refer also to abstracts 9498, 9517, 9557, 9558, and 9596–9598.

9638 LESIONS OF THE NERVOUS SYSTEM THROUGH IONIZING RADIATION. Spiess, H. (Univ., Bern). Ther. Umsch.; 27: No. 6, 379-86(Jun 1970). (In German).

Damage to the central and peripheral nervous systems through ionizing rays is reported. A number of cases are discussed as well as 35 tabulated late syndromes from radiation affecting the peripheral nervous system. It is shown that these effects lead to great pain and dysesthesia considerably less often than previously thought. They appear on the average three to four years after termination of the irradiation. Surgical treatment (neurolysis) is recommended only in exceptional cases. (auth)

9639 NAEVI AND RADIOTHERAPY. Stein, Guenter (Universitaetsklinik fuer Hautkrankheiten, Bonn). Strahlentherapie; 142: No. 1, 34-6(Jul 1971). (In German).

A report on the consequences of radiotherapy of naevocellular naevi is presented. In one case in a 9 year old child a squamous cell carcinoma developed. Naevocellular naevi do not indicate radiotherapy. (auth)

9640 LIGHT FLASHES PRODUCED IN THE HUMAN EYE BY EXTREMELY RELATIVISTIC MUONS. McNulty, P. J. (Air Force Cambridge Research Labs., Bedford, Mass.). Nature (London); 234: No. 5324, 110(12 Nov 1971).

The studies described were made in connection with the reported light flashes observed by the Apollo astronauts, and involved a test of the ability of the human eye to detect Cherenkov radiation when generated with sufficient intensity by the passage of a burst of relativistic charged particles through the vitreous humour and retina. Observations were made during two short periods of exposure to a beam of 6 ± 2 GeV/c muons at the Brookhaven AGS. The muons entered the eye through the side of the head. Pulses of 440 ms duration, with an interval of 2s between pulses, were employed, with a flux density of 3×10^3 muons/cm^2 in each pulse. Bright diffused flashes were observed, appearing and disappearing with the beam pulses. When the beam entered from the rear of the head the flashes were no longer clearly distinguishable. The small LET values and total dose involved in producing the flashes appeared to rule out any significant contribution from direct ionization and excitation. Cherenkov radiation appears to be the most plausible mechanism for producing the flashes. (UK)

9641 RADIATION REACTIONS IN CERVICAL CANCER THERAPY. Buchler, Dolores A.; Kline, Joyce C.; Peckham, Ben M.; Boone, Max L. M.; Carr, W. F. (Univ. of Wisconsin, Madison). Amer. J. Obstet. Gynecol.; 111: No. 6, 745-50 (15 Nov 1971).

Between 1961 and 1969, there were 410 patients treated for invasive squamous cell carcinoma of the cervix with either intracavitary therapy alone or in combination with external radiation. This group of patients was reviewed for reactions occurring during treatment as well as one month after completion of treatment. The reactions were subdivided into mild, moderate, and severe. As the gastrointestinal reactions became more severe, the chance for a subsequent complication increased significantly. Though patients had no problems during the course of radiation therapy, it appears a certain per cent will still develop complications later. The same relationship was not observed for the genitourinary system. The majority of patients developing a genitourinary complication had no significant symptoms during the reaction period. (auth)

9642 SUGGESTED PROPHYLAXIS FOR OVARIAN CANCER. A 20 YEAR REPORT FROM CASES OF BUTTERWORTH HOSPITAL. Gibbs, E. Kent (Butterworth Hospital, Grand Rapids, Rapids, Mich.). Amer. J. Obstet. Gynecol.; 111: No. 6, 756-65 (15 Nov 1971).

From 1949 to 1969, 236 cases of ovarian malignancy were seen at Butterworth Hospital, Grand Rapids, Michigan. Of these cases, 85.6% occurred beyond age 41. Sixty-nine per cent of the ovarian cancer was in Stages III and IV. The over-all 5-yr survival for all stages was 15.7%. Previous operations were performed in 126 patients. Twenty-eight patients had prior hysterectomies. The expected incidence of ovarian carcinoma following hysterectomy was observed. Ovarian cancer may develop in

patients having prior irradiation to the ovaries and breast or gastrointestinal malignancy. It is suggested that a radical approach to pelvic operation in women beyond age 35 could prevent 20% of all ovarian carcinoma seen. (auth)

9643 BLOOD LYMPHOCYTE REPLICATING ABILITY AS A MEASUREMENT OF RADIATION DOSAGE. Ilbery, P. L. T.; Rickinson, A. B.; Thrum, C. E. (Univ. of Sydney). Brit. J. Radiol.; 44: No. 527, 834-40(Nov 1971).

Lymphocyte replicating ability, assessed by ^{3}H-thymidine uptake in +8 and 72-hour cultures of blood lymphocytes exposed to phytohaemagglutinin, was determined following incremental doses of in vitro radiation delivered at the beginning of culture. Curves were constructed relating radiation dosage in the kilorad range to the subsequent depression in ^{3}H-thymidine uptake, the effect of irradiation being more marked at the later labelling time. The lymphocyte replicating ability shown in cultures set up from radiotherapy patients was compared with that shown in cultures from matched normal subjects on a number of occasions spanning the course of the patient's treatment. After high in vivo dosage localized over sites containing major blood vessels, the patients' lymphocyte response in culture appeared to be markedly depressed. In a number of cases the degree of depression observed was similar to that seen in lymphocyte cultures from normal subjects following in vitro exposure of the cells to doses of several hundred rads. Possible mechanisms whereby such radiation effects might arise are discussed. (auth)

9644 MICRODENSITOMETRIC ANALYSIS OF THE INFLUENCE OF X-IRRADIATION ON MATURE BONE IN HUMANS. Malska-Waniewska, Izabella (Military Medical Academy, Lodz, Poland). Acta Med. Pol.; 12: No. 3, 357-80(1971).

Roentgenograms of the necks of the femur irradiated therapeutically with x rays have been assessed by the microdensitometric method in 36 adult women treated for carcinoma of the reproductive organs. The microdensitometric curves were analyzed by statistical methods. Changes in optical density (calcification) of bone appeared within 2 to 4 days after exposure to ionizing energy and persisted throughout six months of observation. In a majority of cases calcification of bone diminished, but in some cases increased calcification was observed. Individual differences in the occurrence and intensity of this type of postradiation reaction were noted. (auth)

9645 IATROGENIC IMPAIRMENT OF THE AUDITORY AND VESTIBULAR APPARATUS. Neiger, M. (Univ., Bern). Ther. Umsch.; 27: No. 6, 400-3(Jun 1970). (In German).

Iatrogenic lesions of the auditory and vestibular organs may result from the use of instruments (rinsing of the ear, removal of foreign bodies, paracentesis). They affect either only the middle ear (perforation of the tympanic membrane, dislocation or fracture of the auditory ossicles) and become evident by middle-ear deafness, or they also involve the inner ear (opening of the vestibulum in the oval window, fracture of the promontory) and are most often the reason of deafness. Iatrogenic damage may also occur in operations of the ear or may be caused by drugs, particularly ototoxic antibiotics of the streptomyces group. Hardness of hearing, complete inner-ear deafness and vertigo as manifestations of partial or total degeneration of the sensory epithelium constitute the well-known side effects. Mention is also made of acoustic trauma caused by high-speed dental drills as well as damage to the auditory and vestibular organs through x-rays and similar rays used for therapeutic irradiation of the ear region. (auth)

9646 HUMAN RADIATION EFFECT: AN OVERVIEW. Sagan, Leonard A. (Palo Alto Medical Clinic, Calif.). Health Phys.; 21: No. 6, 827-33(Dec 1971).

Late somatic and genetic effects of radiation exposure are reviewed, with emphasis on the human experience, but including animal experience where necessary. Particular attention was directed to dose-response relationships, and to studies of low dose effects. It is concluded that evidence is inconclusive with respect to effects in the range of exposures permitted by current radiation standards. (auth)

9647 SYMPTOMS OF RADIATION DISEASE AND VARIOUS SEQUELAE IN MAN WITH SPECIAL REFERENCE TO THE VICTIMS OF THE HIROSHIMA AND NAGASAKI ATOMIC EXPLOSIONS. Szirmai, Endre; Medgyesi, Gyorgi; Srebro, Zbigniew (Inst. of Nuclear Hematology, London). Przegl. Lek.; 28: No. 3, 253-7(1971). (In Polish).

Earlier and current views on the pathogenesis of radiation disease in man are briefly presented and its cause sketched out on the basis of observations made on the victims of the atomic explosions at Hiroshima and Nagasaki and on the Rongelap atoll. The development and symptomatology of later radiation sequelae are also discussed. On account of the topicality of the problem, some relevant questions in human radiation genetics are discussed somewhat more widely. (auth)

9648 PAPERS PRESENTED AT THE ANNUAL MEETING OF THE EXPERIMENTAL HEMATOLOGY SOCIETY, PITTSBURGH, PENNSYLVANIA, NOVEMBER 12-13, 1970. Exp. Hematol.; No. 21, 1-40(1971). (CONF-701142-(Absts.)).

Abstracts of 39 papers presented at this conference are included. Emphasis was placed on the relationship of immune reactions to the etiology of hematopoietic system neoplasms in mice and immune reactions in human patients with hematopoietic dyscrasias following allogenic or isogenic bone marrow transplants. Whole-body x irradiation was used to suppress immune reactions prior to administration of bone marrow transplants in some of the studies reported. (C.H.)

9649 ETIOLOGICAL FACTORS IN OSTEORADIONECROSIS. Degering, Charles I. (Washington Dental School, Seattle). Conn. State Dent. Ass.; 45: No. 1, 13-23(Jan 1971).

A review of factors involved in the development of osteoradionecrosis is presented. The following topics are discussed: physical factors; source or type of radiant energy; amount of radiant energy; biological factors; absorption of energy; and patient predisposition. It was concluded that the incidence of necrosis may be reduced by ultra-fractionation, protraction, collimation, and filtration of the dosage; zones of radiation hazard may serve as guidelines in treatment planning for retention or prophylactic removal of the dentition; and pre-irradiation oral treatment as oral hygiene, dental restorations, balanced dentition, and regular post-irradiation oral examinations to treat incipient lesions may appreciably reduce the incidence of osteoradionecrosis. (H.L.W.)

9650 RADIATION-INDUCED EMBRYOPATHY. Zwicker, H.; Felix, R.; Thelen, M. (Univ., Bonn). Strahlentherapie; 142: No. 1, 37-43(Jul 1971). (In German).

A 19 year old patient suffering from Hodgkin stage IV became pregnant during the cobalt-60 teletherapy. The pregnancy remained unknown for an additional 22 days of radiotherapy. The right and left cervical zones were irradiated, both axillae as well as the mediastinum. The embryo was exposed to a radiation dose of 3R according to the Alderson Phantom measurement. Literature reviews show that animal experiments on radiation-induced embryopathy also apply to man if the conditions of time and quantity are correctly transferred. In the above case one could not expect that the therapy damaged the proliferating cells which was confirmed by birth of a healthy girl. (auth)

Radiation Effects on Plants

Refer also to abstracts 9499, 9501, 9509, 9512, 9515, 9516, 9565, and 9567.

9651 (RT/EL-(71)2) PHYSICO-CHEMICAL ASPECTS OF RADIOSENSITIVITY OF PLANT SEEDS INFERRED FROM THE ANALYSIS OF THERMALLY STIMULATED RADIOLUMINESCENCE. Caserta, G.; Cervigni, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 38p. Dep. NTIS (U. S. Sales Only).

Twelve species of plant seeds were exposed to 7 to 130 kR of x radiation and LD_{50} values were determined by measuring the survival at the seedling stage. Seeds were analyzed for saponifiable and nonsaponifiable components and a measuring apparatus for thermoluminescent glow curves is described. Correlations between thermoluminescent glow curve parameters and radiosensitivity are described for whole seeds, saponifiable lipids, and nonliposoluble components and nonsaponifiable lipids. Results are presented in the form of graphs. Trap spectra for saponifiable lipids of seeds of Raphanus sativus and Helianthus annuus were determined. The significance of the results is discussed with regard to thermoluminescent dosimetry and mechanisms of energy transfer and distribution. (H.L.W.)

9652 RADIATION DAMAGE OF BOUND AND FREE RIBOSOMES IN GERMINATING BARLEY SEEDS. Naito, Tadao; Tokuda, Hatsue; Yamaguchi, Hikoyuki (Tokyo Univ.). Radioisotopes (Tokyo); 20: No. 7, 327-30(Jul 1971).

Embryos were excised from the seeds of naked barley after 24 hrs soaking and were irradiated with 1, 2, and 3 kR of ^{137}Cs γ rays. Microsomal fractions of these embryos were separated by sucrose gradient centrifugation. Cells of germinating seed embryo contain both free and bound ribosomes. The ratio of bound to free ribosomes decreased with an increase in dose. There was no significant difference in the yield of microsomal fraction between the nonirradiated and the irradiated except at 3 kR. Thus, it was concluded that the yield of free ribosomes increased at the expense of the bound ribosomes at 1 and 2 kR irradiation, and that at 3 kR the degradation of ribosomes per se, in addition to de-

tachment of bound ribosomes from the membranes, occurred. For only irradiated samples, a membrane-like substance was found visibly floating in ethanol solution during the process of extracting RNA from the 105,000 g supernatant. (auth) (Japan)

9653 COMPARATIVE CYTOLOGICAL ANALYSIS OF THE EFFECT OF X RAYS AND GIBBERELLIC ACID ON SUNFLOWERS. Beglaryan, N. P.; Avetisyan, A. V. (Erevan State Univ.). Tsitol. Genet.; No. 3, 227-30(1971). (In Russian).

When studying the sunflower plants treated with x-rays and gibberellic acids, the physiological and genetic activity of the above-mentioned factors was found. The established effective doses and their concentration had both stimulating and genetic effects on the sunflower, increasing the mitotic activity of cells and causing structural rearrangements of the chromosomes. (auth)

9654 APICAL AND NON-APICAL MERISTEM LETHALITY IN RELATION TO CHROMOSOME NUMBER, NUCLEAR VOLUME, AND RELATIVE RADIOSENSITIVITIES IN DIPLOID AND TETRAPLOID ANTIRRHINUM MAJUS. Miller, M. W.; Colaiace, Joyce D. (Univ. of Rochester, N. Y.). Radiat. Bot.; 11: No. 5, 389-95(Oct 1971). (UR-49-1352).

Diploid and tetraploid seedlings of snapdragons (Antirrhinum majus) were irradiated with increasing exposures of x rays and scored 6 to 8 weeks later for apical and non-apical (adventitious) proliferation. Apical and non-apical proliferations were eliminated in both strains with exposures of 8 kR and 14 kR, respectively. All non-apical shoots arose from the juncture of the root and shoot. Interphase chromosome volumes (icv) of shoot apices and of the meristematic areas of non-apical proliferation were 4.4 ± 0.2 μ^3 and 2.6 ± 0.2 μ^3, respectively, for the diploid and 4.4 ± 0.3 μ^3 and 1.9 ± 0.1 μ^3, respectively, for the tetraploid; the corresponding energies absorbed per chromosome at LD_{100} average to 1.9×10^6 eV — considerably below Sparrow's constant of 3.6×10^6 eV for seedling survival. Decapitated 2n and 4n seedlings had a higher LD_{100} (20 kR) and a correspondingly higher average energy absorbed per chromosome (2.6×10^6 eV) for non-apical proliferation. It is suggested, because a plant has several types of meristems capable of producing a shoot, that survival be compared against its relative ICV; that is, apical survival against apical ICV and non-apical survival against whatever non-apical meristem produces the plant shoot. (auth)

9655 ACUTE GAMMA IRRADIATION OF THE WHEAT PLANT: EFFECTS OF EXPOSURE, EXPOSURE RATE, AND DEVELOPMENTAL STAGE ON SURVIVAL, HEIGHT, AND GRAIN YIELD. Killion, D. D.; Constantin, M. J. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. Radiat. Bot.; 11: No. 5, 367-73(Oct 1971).

Winter wheat (Triticum aestivum L. em. Thell "Seneca") plants at different developmental stages were exposed to ^{60}Co γ radiation at different exposures and exposure rates. The interaction of exposure × exposure rate × developmental stage was found to be significant ($P < 0.05$) for all biological effects, i.e., survival and height at maturity, and grain yield. Survival was reduced to essentially zero with 1.6 kR at 40 R/min, but unaffected at 5 R/min, in those plants irradiated at 1- through 4-leaf stage, whereas survival of plants irradiated at winter-dormant through anthesis stage was unaffected by 1.5 kR at 20 R/min, the highest rate used. Height was reduced to a maximum of approximately 60% of control in plants at the 1- through 4-leaf stage exposed to 1.6 kR at a rate of 10 R/min or more. The greatest reduction in grain yield occurred in those plants irradiated at the meiotic and gametogenic stages. At these development stages, grain yield was essentially zero with 1.5 kR at an exposure rate as low as 5 R/min. (auth)

9656 INFLUENCE OF LIGHT INTENSITY AND TEMPERATURE ON GROWTH OF FENUGREEK (TRIGONELLA FOENUM-GRAECUM, L.) BEAN SEEDLINGS, FROM GAMMA-IRRADIATED SEED. Looper, Jane Anne; Aboul-Ela, Mohamed M. (Texas Woman's Univ., Denton). Radiat. Bot.; 11: No. 5, 355-61(Oct 1971).

Gamma irradiation of dry seed of fenugreek beans indicated that the subsequent damage shown by growing seedlings was slightly modified by the growing conditions. Dry weights of the entire 21-day-old seedlings as well as the various seedling parts indicated significant interaction effects between temperature × radiation, and temperature × light. Dry weights of the cotyledons of all seedlings from irradiated seed were higher than those from their unirradiated controls. (auth)

9657 EFFECT OF γ-IRRADIATION OF POLLEN ON SELF-INCOMPATIBILITY IN THE APPLE TREE. Kichina, V. V.; Aleshin, V. M. (Research Zonal Inst. of Horticulture of the Non-Chernozem Region, Moscow). Genetika; 7: No. 10, 23-6(Oct 1971). (In Russian).

Gamma irradiation of apple pollen at doses of 300, 700, and 1,000 R did not stimulate the germination of pollen in a 10% sucrose solution. The development of fruits and seeds after self pollination increased for some varieties at a dose of 300 R but not at higher doses. Irradiation of pollen before self pollination of striped varieties resulted in a decrease of fruit and seed production. Differences in pollen radioresistance made it possible to divide the varieties into two distinct groups based on their reactions to small doses of radiation. (auth)

9658 INFLUENCE OF LIGHT ON THE RADIATION EFFECT OF PROTON AND GAMMA IRRADIATION ON CABBAGE LEAVES. Skukina, I. S.; Shaidorov, Yu. I.; Nekrasova, V. N. Kosm. Biol. Med.; 5: 84-7(Sep-Oct 1971). (In Russian).

This study of the effect of illumination on irradiated cabbage leaves was divided into three parts. A protective effect of light in the region of from 1,600 to 4,000 lux on the stability of the plants toward γ radiation was noted, the effect increasing with greater illumination. Increasing the latter to 7,000 lux had no further effect. The role of the intensity of plant illumination during pre- and post-radiation periods was studied: less illumination during the post-radiation period reduced the destructive effect of the ionizing radiation, as compared with more illumination. Experiments with protons also showed that the conditions of the illumination could affect the effectiveness of the radiation; the results were even more pronounced than in the case of gamma radiation. (K.S.W.)

9659 RADIATION-INDUCED SINGLE-STRAND BREAKS IN THE DNA OF DORMANT BARLEY SEEDS. El-Metainy, Ahmed; Takagi, Masamichi; Tano, Shigemitsu; Yamaguchi, Hikoyuki (Tokyo Univ.). Mutat. Res.; 13: No. 4, 337-44 (Dec 1971).

The efficiency of γ-ray-induced single-strand breaks in the DNA of dormant barley seeds was studied using a modified alkaline sucrose density gradient technique. The diphenylamine reagent was used for the assessment of the distribution of DNA molecules in the gradient after centrifugation. Reproducible sedimentation patterns were obtained, when 200 or 300 μg of DNA were used, but with higher amounts of DNA non-reproducible patterns were obtained. For the standardization of the sedimentation rates and the molecular weights calculated for the DNA of dormant barley seeds, under the conditions of this experiment, T_4 phage DNA was used as a marker of known molecular weight. The number-average molecular weight of the DNA of the un-irradiated dormant barley seeds was found to be $0.79 \cdot 10^8$. The sedimentation patterns of the DNA of dormant barley seeds were studied after γ-irradiation with 10, 20, 30 and 40 kR (80, 70, 40 and 30% relative reduction in seedling height, respectively). The decrease in the sedimentation velocity of the irradiated samples compared with the un-irradiated controls was taken as an indication of the efficiency of radiation-induced single-strand breaks. Furthermore, a linear relationship was found between the number of induced single-strand breaks/g DNA and the applied radiation dose. The energy required for the induction of a single-strand break per gram of DNA was 90 eV. (auth)

9660 RECOVERY OF HAPLOID YEAST SACCHAROMYCES CEREVISIAE FROM DOMINANT LETHALS INDUCED BY IONIZING RADIATION. II. INFLUENCE OF DOSE FRACTIONATION AND POSTIRRADIATION INCUBATION ON MINIMAL MEDIUM ON ZYGOTE SURVIVAL. Belostotskaya, G. B.; Vdovichenko, T. A. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 7: No. 12, 60-4(Dec 1971). (In Russian).

It is shown that recovery of haploid yeast from sublethal and dominant lethal damages exists on minimal media. Recovery of haploid cells is in principle the same as recovery of cells of higher ploidy. Basically, the mechanism of recovery does not require the second genome in a cell. (auth)

9661 EFFECT OF REPEATED RADIATION ON RADIOSENSITIVITY OF HARD WINTER WHEAT. Prikhozhenko, E. Ya.; Belichenko, N. I. (Rostov State Univ., Rostov-on-Don, USSR). Tsitol. Genet.; No. 2, 121-5(1971). (In Russian).

Germinated seeds of Triticum durum var. aegupticum were exposed to x-rays in doses 0.5; 1.0; 1.5; 2.0; 3.0 kR. No linear dependency was found between the chromosome aberration frequency and the dose during repeated radiation treatment of wheat seeds. The dependency is much more complicated. After repeated exposure there was found a tendency to selection of organisms with a higher physiological defence against radiation. Offsprings of repeatedly exposed organisms have a higher critical radiation dose and higher radioresistance. If radiation doses are higher than the critical one, there is a decrease in mitotic activity of cells. (auth)

9662 NOTE ON THE EFFECT OF X IRRADIATION OF GROWING EMBRYOS IN RICE. Palanichamy, K.; Singh, V. P.; Siddiq, E. A. (Indian Agricultural Research Inst., New Delhi). Curr. Sci. (India); 40: No. 22, 610-11(20 Nov 1971).

Seedlings of rice (Oryza japonica) were exposed to a 2 kR dose of x radiation at different developmental stages. The seeds from the irradiated plants were sown in pots and the M_1 plants were examined for survival, shoot length, and seed germination rate. The progeny of plants irradiated during the first two days of development showed a marked reduction in survival rate, pollen fertility, and seed fertility with a progressive reduction in radiation effects observed in relation to maturity of the seedlings at the time of irradiation. (C.H.)

9663 STUDIES ON THE EFFECTS OF RADIATION FROM RADIOISOTOPES INCORPORATED INTO PLANTS. V. THE RESIDUAL EFFECTS OF INTERNALLY ADMINISTERED ^{32}P ON THE GERMINATION AND GROWTH OF YOUNG SOY BEAN, MILLET, AND SALVIA. Kim, Kil Hwan; Kim, Hee Kon; Cha, Jong Whan. Korean J. Hort. Sci.; 6: 85-92(1969).

Soy bean, millet and salvia seeds produced in the previous year in a pot culture in which nine levels of carrier-free ^{32}P solution (ranging from 1.09×10^{-4} to 1.09×10^{4} μc/pot in soy bean, from 0.65×10^{-4} to 0.78×10^{4}/μc pot in millet and salvia) were introduced immediately before florescence into each plant stem through absorbent cotton thread, were used for germination test and water culture in order to observe the residual effect of ^{32}P applied in the previous year. (Korean Sci. Abstr.)

Radiation Effects on Microorganisms

Refer also to abstract 9502.

9664 REPAIR OF UV-DAMAGED DNA IN BACILLUS SUBTILIS. Filippov, V. D. (Moscow State Univ.). Genetika; 7: No. 10, 71-81(Oct 1971). (In Russian).

It is shown that extract of Bacillus subtilis produces the same number of single-stranded breaks both in uv-irradiated and non-irradiated transforming DNA of Bac. subtilis and also in uv-irradiated and non-irradiated denatured DNA. After uv-irradiation, an intensive many-forked replication of DNA occurs, leading to an increase of TA of genetic markers at an initial period of post-irradiation incubation. Increased TA of markers have an increased sensitivity to extract Micrococcus luteus. These facts make it impossible to determine the reparation rate of DNA markers. After prolonged post-irradiation incubation of cells in conditions of increasing suspension turbidity, a decrease of TA of markers takes place. Probably, it is indicative of the change of irradiated population to normal exponential growth. An interpretation is given that in Bac. subtilis cells postreplication or polar repair of the chromosome occurs in the absence of uv-endonuclease. A model of repair of uv-damaged DNA during replication is given. (auth)

9665 MICROBIOLOGICAL QUALITY CONTROL OF STERILIZED PRODUCTS: EVALUATION OF A MODEL RELATING FREQUENCY OF CONTAMINATED ITEMS WITH INCREASING RADIATION TREATMENT. Tallentire, A. (Univ. of Manchester, Eng.); Dwyer, J.; Ley, F. J. J. Appl. Bacteriol.; 34: No. 3, 521-34(Sep 1971).

A model describing the dependence of the proportion of items contaminated (P) in a population of items on radiation dose (D) was developed. The model was evaluated for a range of doses assuming a Poissonian distribution of microorganisms on items prior to and during irradiation and radiation inactivation according to multiple-hit kinetics; curves relating P and D were constructed. The influence on curve shape of changing the initial average number of micro-organisms on items and of varying parameters of microbial sensitivity to radiation was assessed. Consideration was given to the value of using sub-process radiation doses in microbiological quality control testing. (auth)

9666 KILLING ACTION OF BLEOMYCIN ON RADIATION-SENSITIVE MUTANTS OF ESCHERICHIA COLI. Suzuki, Kenshi (National Inst. of Radiological Sciences, Chiba, Japan). Jap. J. Genet.; 46: No. 4, 277-80(Aug 1971).

Culture media and strains of bacteria used in the experiments are described. Three physiologically different cultures were used in the experiments: stationary phase cultures, growing phase cultures, and amino acid starved bacteria. Survival was determined following exposure to bleomycin and graphs are presented to show results. There was no difference between radiosensitive and radioresistant strains in sensitivity to bleomycin. All strains showed higher resistance to bleomycin in stationary phase than in growing phase. Degradation of DNA was estimated from the amount of radioactivity remaining in the acid-insoluble fraction of bacteria labeled with ^{3}H-thymidine. There was an extensive degradation of DNA in cells exposed to bleomycin. (H.L.W.)

Radiosterilization and Radiopreservation

Refer also to abstracts 9468 and 9665.

9667 (STI/PUB-299) DISINFESTATION OF FRUIT BY IRRADIATION. Panel Proceedings Series. Proceedings of a Panel Held in Honolulu, Hawaii, 7-11 December 1970. (International Atomic Energy Agency, Vienna (Austria)). Oct 1971. 182p. (CONF-701222). IAEA $5.00.

Separate abstracts were prepared for thirteen papers presented at the conference. Two additional papers are included on quarantine regulations for import and export. (H.L.W.)

For abstracts of individual papers see: 9674-9686.

9668 MACHINE FOR STERILIZED PACKAGING. (to Societe d'Etudes et Exploitation de Procedes pour l'Industrie Alimentaire). French Patent 2,049,224. 15 Mar 1971. Filed 4 Jun 1969. (In French).

A machine for the sterilized packaging of liquid, powdered, or solid products, is described. The principal concern is with food products, sachet type milk containers being of particular concern. Special means are provided whereby the container and the product with which it is to be filled enter a sealed enclosure, the filling takes place, and the filled container leaves the sealed enclosure. The packaging material is irradiated by a beam from a particle accelerator, which passes through a hole in the enclosure wall. A mixture of filtered air, and some ozone produced by the radiation, is maintained at a slight excess pressure within the enclosure. (France)

9669 RADIOSTERILIZATION OF MEDICAL PRODUCTS. II. Uhlig, K. Isotopenpraxis; 7: No. 5, 155-9(May 1971). (In German).

Radiation sources and radiation installations for radiosterilization of medical products are described. For practical application, only γ-emitters and electron accelerators are of importance. Advantages and disadvantages of the two types of installation are listed with respect to radiation capacity, economics, and radiation safety. At the present time, about 90% of radiation installations use γ-emitters, especially ^{60}Co. (H.B.G.)

9670 TECHNIQUE FOR THE DETECTION OF LOW DOSE γ IRRADIATION IN COOKED DUTCH SHRIMP (CRANGON CRANGON) BY DISC PROTEIN PATTERNS. Adriaanse, A. (Agricultural Univ., Wageningen, Netherlands). J. Sci. Food Agr.; 22: No. 9, 498-9(Sep 1971).

Cooked and peeled shrimps were irradiated under air at levels of 50, 100, and 300 krad. Disc patterns of salt-extracted proteins of these samples showed a series of radio-characteristic effects. Based on these effects, a method for the detection of low dose irradiation was developed. In addition, the applied dose can be estimated. (auth)

9671 STUDIES ON THE STORAGE OF APPLES. III. INFLUENCES OF COMBINED TREATMENT OF COATING MATERIALS AND GAMMA RADIATION ON THE STORAGE QUALITIES OF APPLES. Park, Nou Poung; Choi, Eon Ho; Lee, Ok Hwi. Korean J. Hort. Sci.; 8: 51-3(1970).

Combined treatment of coating materials and gamma radiation to apples was attempted to minimize side-effects caused by gamma irradiation. Apples were treated with OED, OED-G, and CMC to control their transpiration and respiration and these apples, under modified internal atmosphere, were subjected to low-level irradiation. Advantages of the combined treatment of coating and gamma-irradiation for extending storage life of the apple were not observed. (Korean Sci. Abstr.)

9672 STUDIES ON THE STORAGE OF PEARS. I. INFLUENCES OF GAMMA IRRADIATION ON THE STORAGE OF PEARS CHANGSYPRANG. Park, Nou Poung; Choi, Eon Ho; Lee, Ok Hwi. Korean J. Hort. Sci.; 8: 55-8(1970).

Pears, Changsyprang, were subjected to 100 to 300 krad of ^{60}Co gamma-ray immediately after harvest in order to improve their keeping qualities. Changes in the qualities and chemical contents were investigated. Gamma-irradiation, especially 300 krad, delayed ripening of pears and controlled fruit scald. Irradiated lots showed somewhat higher sugar content and lower pH than control during storage. (Korean Sci. Abstr.)

9673 EFFECT OF IRRADIATED LOW SUGAR GUAVA JELLY ON THE GROWTH AND MITOSIS IN BARLEY (HORDEUM VULGARE). Murali Krishna, M.; Jain, N. L.

(Indian Agricultural Research Inst., New Delhi). Sci. Cult. (Calcutta); 37: No. 5, 244-5(May 1971).

The wholesomeness of γ-irradiated guava jelly was investigated using growth and mitosis rate of seedlings of barley (Hordeum vulgare) as the test system. Irradiated and unirradiated jelly was diluted with distilled water and added to the water used to soak barley seeds. The roots and shoots of seedlings were examined 12 hours later. Seedlings treated with irradiated jelly showed 22.21% inhibition of shoot growth and 53.11% inhibition of root growth when compared with those treated with nonirradiated jelly. There was also a marked reduction in the mitotic index and an increase in the number of chromosome breaks in cells of seedlings treated with irradiated jelly. (C.H.)

9674 OVERVIEW OF USAEC INTEREST IN FOOD IRRADIATION. Fowler, E. E. (Division of Isotopes Development, Washington, D. C.). pp 1-5 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

A summary progress statement on the U. S. Atomic Energy Commission's program on food irradiation is presented. Detailed information on the work supported by the USAEC on the disinfestation by irradiation of papayas is given and also the actual status of research and the economic prospects of this treatment. (auth)

9675 HAWAII DEVELOPMENT IRRADIATOR: A TOOL IN TROPICAL FRUIT PROCESSING. Otagaki, K. K. (Dept. of Agriculture, Honolulu, Hawaii). pp 7-10 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

The state of Hawaii has embarked on a development program to further the marketing potential of tropical fruits through the application of nuclear energy as a disinfestation process. The quasi-commercial Hawaii Development Irradiator (HDI) serves as a forerunner to the establishment of full-scale commercial irradiation facilities in the Pacific rim countries. (auth)

9676 USDA RESEARCH ON IRRADIATION TO SOLVE QUARANTINE PROBLEMS IN FRUIT. Cox, H. C. (U. S. Dept. of Agriculture, Beltsville, Md.). pp 23-5 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Research on the use of ionizing radiation as a possible broad-spectrum quarantine treatment for subtropical fruits was first initiated at the USDA Fruit Fly Laboratory in Honolulu in 1949. Advances have been made with fruits infested by different insects. Alternative approaches to the problem will be discussed for certain areas. (auth)

9677 DOSE REQUIREMENTS FOR QUARANTINE TREATMENT OF FRUIT FLIES WITH GAMMA IRRADIATION. Burditt, A. K. Jr. (U. S. Dept. of Agriculture, Beltsville, Md.); Seo, S. T. pp 33-41 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

The Entomology Research Division, Agricultural Research Service, United States Department of Agriculture at its Honolulu, Hawaii laboratory is investigating the use of γ irradiation as a possible quarantine treatment for three species of tropical fruit flies, the oriental fruit fly, Dacus dorsalis Hendel, the Mediterranean fruit fly, Ceratitis capitata (Wiedemann), and the melon fly, D. cucurbitae Coquillett, and for the mango weevil, Sternochetus mangiferae (F.). The emergence of adults from irradiated naked eggs or larvae or from puparia containing fourth instar larvae was prevented by 15 kR of gamma irradiation, but larger doses were required to prevent emergence of irradiated pupae. Also, immature flies protected by water or by fruits required higher doses than similar flies that were unprotected. The logarithm of the minimum doses which were needed to prevent adult emergence from infested fruit packaged for export from Hawaii was related by regression to thickness of the package. Mango weevil infestations in seeds were killed by minimum doses of 20.8 to 32.9 krad depending on thickness of the package. At lower doses adults did not produce sperm or eggs during their lifetime. (auth)

9678 DOSIMETRY, TOLERANCE, AND SHELF-LIFE EXTENSION RELATED TO DISINFESTATION OF TROPICAL FRUITS BY GAMMA IRRADIATION. Moy, J. H.; Akamine, E. K.; Brewbaker, J. L.; (and others) (Univ. of Hawaii, Honolulu). pp 43-57 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Six aspects of disinfesting tropical fruits by γ irradiation are summarized. The pool-type Hawaii Research Irradiator with 30,000 Ci(1965) of cobalt-60 was used for various studies, with maximum dose rates of ca.4.7 krad/min (papaya-filled) and 5.2 krad/min (air) in the central chamber after upgrading in 1968. Tolerance doses of eight different types of tropical fruits were determined; papaya, mango and banana, tolerable to 100 krad, were most promising. Biochemical, physiological and chemical studies on the papaya's (var. Solo) response to post-harvest ripening and to γ radiation showed peroxidase activity in fruit pulp increased significantly during post-harvest storage, but unaltered by low-dose irradiation to 100 krad. The chemical composition of papaya was not affected by doses up to 125 krad. Variation in some analyses was due mainly to fruit ripeness at harvest. Extensive organoleptic evaluations of irradiated papaya showed qualities unchanged at 100 to 150 krad. Qualities of irradiated mango (var. Haden) were retained at 150 krad; lychee (6 var.), 100 krad; banana, 100 krad, and pineapple, 150 to 200 krad. Marketable life of initially ¼-ripe papaya treated with hot water (120°F, 20 minutes for decay control) averaged 6.5 days when stored at ambient temperature (73 to 80°F); combined hot water and irradiation at 75 krad resulted in ca. 9.6 days. Large-scale shipping studies showed marketable life of irradiated papaya consistently equal to or better than those of controls or other quarantine treatments. Market analysis and a consumer acceptance study indicated three out of four persons will buy irradiated papaya if treatment is approved by regulatory authorities. (auth)

9679 RADIATION TECHNIQUES AND THE EXPORT OF MANGOES FROM THE PHILIPPINES. Clarke, I. D. (Univ. of Ibadan, Nigeria). pp 59-64 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Several varieties of mango are widely grown in the Philippines, but the most important commercial variety is the carabao variety. The carabao mango possesses excellent flavour as well as good textural properties and is acceptable to people of different tastes and origin. Approximately 134,090 tons of mango were produced in 1967 from 46,000 hectares, while only 2895 tons were exported to Hong Kong. At the present time this is the only external market available for the export of mango because of the infestation of the fruits with the fruit fly. The possible use of radiation techniques in solving quarantine problems is discussed, as well as the possible commercial benefits to be derived from developing the existing industry in the Philippines on a larger scale. (auth)

9680 PHYSIOLOGICAL EFFECTS OF GAMMA RADIATION ON SOME TROPICAL FRUITS. Sreenivasan, A.; Thomas, P.; Dharkar, S. D. (Bhabha Atomic Research Centre, Bombay). pp 65-91 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Considerable quantities of mangoes, bananas and other commercially important fruits grown in India are spoiled due to the adverse climatic conditions and lack of adequate storage and transportation facilities. Low-dose radiation treatment has been found to extend the shelf life of this highly perishable produce by delaying ripening and senescence. Certain combination treatments in which radiation is used in conjunction with wax coating, kinetin dip, refrigeration or storage in modified atmospheres gives benefits in terms of a further delay in ripening. These processes could be of advantage in stretching the availability of the fruits as well as in their transportation both within the country and abroad. Some of the biochemical and physiological mechanisms underlying the radiation-induced inhibition of ripening and senescence have been elucidated. Maturity at harvest and the physiological state of the fruit at the time of irradiation have been shown to be important factors for consideration to obtain maximum benefits from the process. The respiratory pattern and onset of climacteric are influenced by irradiation and the alterations induced are characteristic of the fruit. The operation of certain alternate pathways of metabolism, notably a switch-over to the glyoxylate cycle in mangoes and to the pentose phosphate pathway in bananas, has been observed to result from

irradiation. The importance of polyphenol oxidase in browning due to radiation injury has been shown. The need for a realistic approach to the problem of wholesomeness evaluation, and a common legislative basis for the promotion of international trade in fruits subjected to low-dose irradiation are discussed. (auth)

9681 CHEMICAL, ECONOMIC, PHYSICAL, AND PHYSIOLOGICAL LIMITATIONS TO IRRADIATION OF FRUITS. Maxie, E. C.; Sommer, N. F.; Mitchell, F. G. (Univ. of California, Davis). pp 93-100 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Ionizing radiation holds technical promise for controlling ripening and rot in but few commodities in the United States of America. Since refrigeration is required for irradiated commodities, developing nations can expect a greater return on investments in refrigerated facilities than in irradiators. Loss in texture is the major chemical problem limiting the use of irradiation with fruits and vegetables. Increased sensitivity to mechanical injury and to physiological disorders by irradiated commodities are major limiting factors. For most commodities the doses required for disinfestation of insects are not injurious. Thus, the outlook for insect disinfestation by irradiation is considerably more optimistic than is control of ripening and rot. (auth)

9682 SENSORY, CHEMICAL, AND NUTRITIONAL EVALUATION ON THE EFFECT OF IONIZING RADIATION ON MANGOES (MANGIFERA INDICA, LINN), CARABAO VARIETY. Pablo, I. S.; Manalo, Juanita A.; Cardeno, Victoria A. (Philippine Women's University, Manila). pp 101-11 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

The optimum irradiation dose was determined in order to extend the shelf-life of mature-green mangoes when stored at 30°C. It has been found that 60-krad-irradiated mangoes exhibited the lowest percentage of decay after 3 weeks of storage at 30°C. Sixty-seven percent of the unirradiated samples spoiled after 10 days, while only 55% of the irradiated samples spoiled. Sensory evaluation revealed that the irradiated samples were just as acceptable as the unirradiated samples. However, there was a significant difference in colour. Since colour was the main difference between the two samples, column chromatography was used to fractionate the carotenoids. The concentration of the carotenoid eluate, measured as β-carotene, was determined using a Spectronic 20. After 8 days of storage, the β-carotene content of the irradiated sample was significantly higher than the β-carotene of the unirradiated sample. To substantiate further the above findings, the eluate was subjected to thin-layer chromatography. The chromatograms clearly indicate that β-carotene was not destroyed by ionizing radiation at a dose which produced shelf-life extension on mature-green mangoes. In addition to β-carotene analysis, ascorbic acid was determined. It was found that the irradiated samples had higher ascorbic acid contents during storage as compared to unirradiated samples. (auth)

9683 RECENT RESEARCH ON THE INFLUENCE OF IRRADIATION OF CERTAIN TROPICAL FRUITS IN THAILAND. Loaharanu, P. (Office of Atomic Energy for Peace, Bangkok, Thailand). pp 113-24 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Preliminary studies on the effect of γ irradiation on tropical fruits such as mangoes, papayas, rambutans, and longans have been carried out. Irradiation of tropical fruits at optimum doses caused an extension in storage life. No significant differences were detected in terms of nutritive values and organoleptic properties between fruits irradiated at optimum doses and unirradiated fruits. In addition, the combined effects of irradiation and low-temperature storage for the disinfestation of Oriental fruit fly, Dacus dorsalis Hendel in mangoes are described. (auth)

9684 EXTENSION OF STORAGE LIFE OF BANANAS BY GAMMA IRRADIATION. Kao, Hung-yen (Ministry of Economic Affairs, Hsinchu, Taiwan). pp 125-36 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Gamma irradiation of green bananas has been investigated through the use of ^{60}Co in an attempt to delay ripening and increase the storage life of this fruit. Ventilation was necessary in the radiation chamber and the radiation temperature was kept at 12°C in order to decrease radiation damage when the bananas were exposed to γ rays in air. Experimental results showed that the applied dose of 20 to 30 krad was optimum and effective in delaying soluble-solid formation, starch disappearance and respiratory activity. Results showed that the irradiated bananas stored at 12 to 20°C and at 25 to 30°C resulted in a delay in ripening of about 7 and 5 days, respectively. Banana samples were supplied throughout different seasons from the central and southern parts of Taiwan. The chemical analysis of green bananas after picking was carried out for research reference. (auth)

9685 SEMI-COMMERCIAL-SCALE STUDIES ON IRRADIATED PAPAYA. Dollar, A. M. (Dept. of Agriculture, State of Hawaii, Honolulu); Hanaoka, M.; McClish, G. A.; Moy, J. H. pp 137-56 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Three simulated shipping studies and two large shipping studies of papaya have compared the effects of radiation treatment with existing commercial disinfestation methods, which now meet quarantine restrictions. The shelf life of papayas treated by ionizing radiation was consistently equal to, or better than that observed for controls, fumigated or vapour-heat-treated fruits. Irradiation of papayas assures improved shelf life through delayed softening. There is no significant improvement by treating at the higher or 75-krad minimum absorbed dose. (auth)

9686 BENEFIT-COST ANALYSIS FOR EXPORT PAPAYA DISINFESTED BY IONIZING RADIATION. Dollar, A. M.; (Dept. of Agriculture, State of Hawaii, Honolulu); Hanoka, M.; McClish, G. A. pp 157-66 of Disinfestation of Fruit by Irradiation. Vienna; International Atomic Energy Agency (1971).

From Panel on the use of irradiation to solve quaratine problems in the International Fruit Trade; Honolulu, Hawaii (7 Dec 1970). See STI/PUB-299; CONF-701222.

Papaya marketing offers a unique opportunity for early commercialization of an irradiation treatment, since a disinfestation of this product is required for export. The production and marketing of Hawaiian papayas are described in detail. At present radiation disinfestation appears the most logical alternative to the present disinfestation process, and the benefit-cost analysis shows net benefits for this process. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 10033.

9687 (AECL–4062) MATERIALS RESEARCH IN AECL. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct 1971. 22p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

Developments are reported for studies on: radiation synthesis of new and improved materials; development of texture and structure in extruded tubes; extrusion development for nuclear fuels at Chalk River; radiation effects on carbon fibers; radiation damage in semiconductors; and neutron radiography at CRNL. (P.C.H.)

9688 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Oktober 1971. Band 5, Heft 10. 304 Referate (Register-Nr.3559-4157) 59 Referate (Register-Nr. 484T-542T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. October 1971. Vol. 5, No. 10. 304 Abstracts (Register No. 3559-4157), 59 Abstracts (Register No. 484 T-542 T)). Karlsruhe, Ger.; Gesellschaft Fuer Kernforschung m.b.H (1971). 153p. (In German and English).

9689 FATIGUE DESIGN. Osgood, Carl C. New York; John Wiley and Sons, Inc. (1970). 532p. $25.00.

Methods of predicting fatigue of materials under specified loading and methods of determining allowable fatigue for a required usage time are reviewed. Chapters are included on design approach, fatigue life prediction, and general factors associated with fatigue. (J.R.D.)

9690 METALLOGRAPHY OF THE SUPERALLOYS. Radavich, John F. (Micro-Met Labs., West Lafayette, Ind.); Couts, Wilford H. Jr. Rev. High Temp. Mater.; 1: No. 1, 55-96(Aug 1971).

The use of modern metallography in the preparation of nickel-base superalloys and the study of the mechanical properties and structure of the superalloys is discussed. Superalloy metallography of the future is mentioned briefly. The superalloys discussed include Inconel 901, Rene 41, Udimet 630, Waspaloy, Astroloy, U dimet 700, IN-100, Af 2-1DA, and TD-Ni. (P.C.H.)

Corrosion and Erosion

Refer also to abstracts 9150 and 9927.

9691 (INIS-mf-65) WELDING CORROSION TESTING AND ZIRCALOY-4 COMPONENTS. De Grande, A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Nov 1970. 17p. (In Spanish). (CONF-701124–1). INIS.

From Metallurgical meeting; Cordoba, Argentina (Nov 1970).

The corrosion behavior in pressurized water and water vapor of welded Zircaloy-4 sheaths and closures for UO_2 fuel rods was studied. The following points were considered: effects produced by different surface treatments in short-duration autoclave tests, preparation of the Zircaloy samples with a nitrogen content between 200 and 600 ppM, and surface contamination with fluorine. From the tests made it was determined that in order to detect nitrogen in quantities between 250 and 300 ppM autoclave treatment of only one day in pressurized water at 300°C and 88 kg/cm^2 gives good results. In order to detect fluorine contamination a treatment of two days more in steam heated to 400°C at 20 kg/cm^2 pressure also gives good results. Increase of the pressure for the fluorine detection to 100 kg/cm^2 yields similar results. (tr-auth)

9692 (NYO–4117-6) DEVELOPMENT OF HIGH TEMPERATURE ROLLING BEARINGS FOR OPERATION IN LIQUID SODIUM. Quarterly Progress Report No. 5, July 1, 1971–September 30, 1971. Jamison, W. E. (SKF Industries, Inc., King of Prussia, Pa. Research Lab.). Contract AT(11-1)-3061. 19p. Dep. NTIS.

Results of tests of candidate materials in high-temperature Na are presented. Descriptions and discussions of tests on Rex 49 flat washers and rollers, and TZM cages at 800°F under loads of 182 kg are included along with information on fabrication of test specimens. (J.R.D.)

9693 (ORNL–4737) EFFECT OF OXYGEN ON THE COMPATIBILITY OF TANTALUM AND POTASSIUM. Klueh, R. L. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 28p. Dep. NTIS.

Static capsule tests were used to study the effect of oxygen in either phase on the compatibility of tantalum and potassium at 600, 800, and 1000°C. As the oxygen concentration of the potassium was increased, the amounts of tantalum in potassium after test also increased. The results indicate the formation of an unidentified ternary oxide phase (probably at the tantalum-potassium interface) that is either nonadherent or dissolved when the potassium is dissolved for chemical analysis. On the other hand, when the tantalum specimens contained oxygen above some threshold concentration that depends on test conditions, potassium penetrated the tantalum; both intergranular and transgranular attack occurred. The threshold levels for intergranular attack at 600, 800, and 1000°C were determined to be 500, 700, and 1000 ppM O, respectively. Again the explanation involves the formation of a ternary oxide phase. (auth)

9694 (ORNL-TM–3587) LOW-TEMPERATURE OXIDATION OF U–Nb AND U–Nb–Zr ALLOYS. Cathcart, J. V.; Petersen, G. F. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 18p. Dep. NTIS.

The rates of oxidation of U–9.4 wt % Nb and U–7.5 wt % Nb–2.5 wt % Zr were measured between 100 and 300°C in purified oxygen. An activation energy of approximately 13 kcal/mole was obtained for both alloys. The effect of H_2O, SO_2, and CCl_4 on the oxidation rate of the ternary alloy was small. Metallographic studies revealed the oxide films to be compact and uniform, although significant oxidation rate anisotropy was observed during the early stages of oxidation. (auth)

9695 (ORNL-TM–3590) EFFECT OF OXYGEN ON TANTALUM–SODIUM COMPATIBILITY. Klueh, R. L. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 20p. Dep. NTIS.

The effect of oxygen in both phases on the compatibility of tantalum with sodium was investigated at 600°C in static capsule tests. Increasing the oxygen concentration of the sodium from 50 to 12,000 ppM led to increased dissolution of the tantalum in the sodium. Oxygen migrated from the sodium to the tantalum, and as the oxygen concentration in the sodium increased, the specimens first gained and then lost weight. Most of the oxygen acquired by the tantalum was in a surface scale. It was concluded that the addition of oxygen to sodium results in the formation of a loosely adhering ternary oxide scale on the tantalum surface. In sodium with more than 1000 ppM O, the ternary oxide also forms along grain boundaries. When the concentration of oxygen in tantalum before test exceeded 200 ppM, sodium penetrated the tantalum. Penetration, as in other refractory metal–oxygen–alkali metal systems previously investigated, proceeds with the formation of a ternary oxide by a wedging mechanism. At low oxygen concentrations attack occurs along grain boundaries, and as the oxygen concentration of the tantalum is increased, the number of grain boundaries attacked and the depth of attack increase. Still higher oxygen concentrations induce transgranular attack. (auth)

9696 (SC-DR–710799) STRESS CORROSION CRACKING BEHAVIOR OF TUNGSTEN FILAMENT REINFORCED U–4½ WT PERCENT Nb. Magnani, N. J.; Romero, Herman; Miglionico, C. J. (Sandia Labs., Albuquerque, N. Mex.). Nov 1971. 15p. Dep. NTIS.

The stress corrosion cracking behavior of tungsten reinforced U-4½ wt% Nb has been studied in 100% relative humidity air. Specimens containing 0, 17, 38, and 51 volume percent tungsten fibers were used in the investigation. The tungsten fibers were perpendicular to a EDM machined precrack. The data have shown that as the tungsten content increases, the susceptibility to stress corrosion cracking decreases to the point where the 51% composite is only slightly susceptible. Fractographic analysis of the specimens indicates that not all of the fibers are equally effective in reinforcing the matrix. (auth)

9697 URANIUM ASSEMBLING BY ADHESIVES. Bordes Pages, H.; Fidelle, J. P.; Roux, C.; Rapin, M. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). pp 97-114 of Adhesive Bonding. /Bordes Pages, H. (ed.). Bruyeres-le-Chatel, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on adhesive bonding; Valduc, France (17 Apr 1969).

In uranium-238 assembling studies, special attention was paid to surface preparations. Some parameters such as electrolytic

polishing, concentration of the baths, rinsing effect of environment, play an important part in surface protection against corrosion. Tests on tensile specimens and on structural adhesive bondings with several surface preparations were performed in different atmospheres: air, argon, nitrogen, and under a slight primary vacuum. After one year the results were very satisfactory but during the second year the corrosion effect was very noticeable and demanded a better surface protection (such as the use of fatty acids). When harmful effects of radioactivity are likely to appear with time, e.g., from ^{235}U, a polyamido–imide varnish, more radiostable than the other adhesives used, may be deposited on the surface, and will at the same time provide extra protection against corrosion. The bond may then be made with the same radiostable adhesive if polymerization can take place at high temperature (290°C), or with a conventional adhesive polymerizing at room or moderate temperature (80°C). (France)

9698 INFLUENCE OF MINOR ALLOYING ELEMENTS ON THE HIGH TEMPERATURE OXIDATION BEHAVIOUR OF A 20 PERCENT Cr–25 PERCENT Ni–Nb STEEL. Antill, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). Werkst. Korros.; 22: No. 6, 513-17(1971).

Relevant published studies on the corrosion behavior of stainless steels in carbon dioxide, in particular of a 20% Cr–25% Ni–Nb steel used for fuel cladding are summarized. Metallurgical conditions including surface finish and the roles of minor amounts of alloying additions such as yttrium, manganese, and silicon were studied in detail. (INIS)

9699 CORROSION OF METALS IN MARINE ENVIRONMENTS. Fink, F. W.; Boyd, W. K. DMIC Rep. No. 245. Columbus, Ohio; Battelle Memorial Institute (1970). 87p.

The ocean environment is described and the factors affecting the corrosivity of seawater are discussed. The forms of corrosion for environments include galvanic attack, crevice attack, pitting, impingement, and cavitation. The corrosion behavior of C steel, low-alloy and stainless steels, Ni, Cu and their alloys, Co, Ti and Ti-base alloys, Al and Al-base alloys, Be, and Mg is discussed; the corrosion behavior of refractory metals, noble metals, Pb, Zn, Cd, and Sn is described separately. The use of cathodic protection with coatings to prevent marine corrosion is discussed. (Metals Abstr.)

9700 CORROSION FATIGUE OF THE PRESSURE VESSEL STEEL FOR PWR AND BWR IN HIGH-TEMPERATURE DEIONIZED WATER. Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 3, 11-15(Mar 1971). (In Japanese).

The behavior of fatigue cracks which occur in high-temperature, high-pressure, deionized water in reactor pressure vessels (RPVs) is examined. The cracks which appear in welded parts of stainless steel lining in the RPVs are like crevices, and corrosion occurs in these areas. Two sorts of crevice specimens were tested in a water loop. Maximum depth of pitting corrosion increased linearly with course of time; however, the number of pits did not change after three months. Preliminary tests of corrosion fatigue were made in deionized water not exceeding 100°C. Changes in crack length were measured by changes of electric resistivity. As temperature increases and cycle speed decreases, growth velocity of cracks increases, and when the cycle speed is low, the effect of the temperature difference is large. When the cracks spread, large plastic deformation was produced around the cracks in air, but in water the plastic deformation was minimal. In water at 200°C, the life span decreased as cycle speed was reduced. Below 10 cpm, however, the life span showed a tendency to increase and as the water temperature increased the cycle speed which resulted in a minimum life span increased. It seems reasonable to conclude that cracks in RPVs do not grow and propagate rapidly. (Japan)

9701 PROBLEMS ON NUCLEAR FUEL MATERIALS FOR WATER REACTORS. Kido, T. (Sumitomo Electric Industries Ltd., Osaka). Genshiryoku Kogyo; 17: No. 3, 5-10(Mar 1971). (In Japanese).

Development of fuel-cladding tubes made of Zircaloy is discussed. The quality of the Zircaloy is determined by the quantity of impurities, especially hydrogen and nitrogen. Zircaloy's crystals are hexagonal, and arrangements of crystals vary according to rolling and drawing methods. Strength of the Zircaloy is determined by direction of hydride orientation. Measurement of the hydride orientation can be made by circumferential elongation in internal pressure rupture testing. The fuel tubes with the desirable hydride orientation can be produced by wall thickness reduction method. The fuel tubes have an inside diameter tolerance of ±0.04 mm. Measurement of the inside diameter and thickness is made using air micrometers and supersonic thickness meters, respectively. As a defect detection method, supersonic waves are employed. The problems of fuel tubes for reactors are corrosion by high-temperature coolant water, hydride precipitation accompanying progress of corrosion, tube rupture because of pressure difference, swelling of fuel pellets in the cladding tubes, and fast neutron radiation effects. (Japan)

9702 RATIO OF SOME CORROSION PRODUCTS OF THE 1X18H9T STAINLESS STEEL IN THE WATER OF THE FIRST COOLING CIRCUIT AND ION-EXCHANGE RESINS OF THE FILTERS OF REMOVING SALTS OF THE IRT NUCLEAR REACTOR. Episheva, S. M.; Kolomiitsev, M. A.; Charbadze, L. A. (Inst. of Physics, Erevan). Soobshch. Akad. Nauk Gruz. SSR; 63: No. 3, 597-9(Sep 1971). (In Russian).

The contents of corrosion products of 1X18H9T stainless steel were studied in different parts of the first cooling circuit of the IRT nuclear reactor. It was found that in spite of uniform elution of stainless steel components during corrosion, a relative enrichment of the water medium with chromium and nickel takes place due to the selective absorption of iron on ion exchange filters. (auth)

9703 OXIDATION OF TUNGSTEN IN AIR. Moisin, Angela Geangu (Univ., Pavia, Italy). Rev. Roum. Chim.; 16: No. 8, 1179-83(Aug 1971).

Studies were carried out on the oxidation of tungsten in air from 600 to 850°C. The results obtained are in good agreement with the parabolic law, for all temperatures. The rate constants follow the Arrhenius law and the calculated activation energy was 40 ± 2 kcal/mole. (auth)

9704 HYDRIDE DISTRIBUTION IN KROLL Zr AND ZIRCALOY-2 AFTER OXIDATION IN STEAM AT 550°C. Gadiyar, H. S.; Sivaramakrishnan, K. S.; Balachandra, J. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Technol.; 9: No.7, 246-50(Jul 1971).

The relationship between the oxidation behavior in steam and the hydrogen adsorption in Kroll Zr and Zircaloy-2 is discussed. Results of metallographic study of hydride distribution in the metal matrix are presented. The hydrogen absorbed was observed to be a function of weight gain in both the cases. (auth)

Preparation and Fabrication

Refer also to abstracts 9088, 9099, 9207, 9208, and 9840.

9705 (BM-RI-7580) COMPARISON OF TECHNIQUES FOR ELECTROWINNING TUNGSTEN FROM SCHEELITE. Gomes, John M.; Uchida, Kenji; Wong, M. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). 1971. 10p.

The Bureau of Mines investigated two techniques for removing CaO from scheelite ($CaWO_4$) prior to electrolysis. In the first technique, a crude tungstic oxide (WO_3) containing 0.15% lime (CaO) was prepared by digesting scheelite concentrates in hot hydrochloric acid. This oxide was used as cell feed to produce tungsten of 99.9% purity. The second technique used a high-temperature, two-phase separation, resulting in extraction of 99% of the WO_3 in the halide-tungstate phase, while 90% of the CaO was retained in the silicate phase. Tungsten of 99.9% purity was deposited from the halide-tungstate melt after B_2O_3 and $NaPO_3$ were added to form an electrolyte. The two methods were compared with a previously developed technique of depositing tungsten from scheelite concentrate fed directly to the electrolytic cell. (auth)

9706 (CEA-R-4179) PROPAGATION OF A SOLIDIFICATION FRONT DURING THE CASTING OF URANIUM INGOTS IN GRAPHITE MOLDS. Cottin, Roger (Commissariat a l'Energie Atomique, Valduc (France). Centre d'Etudes). Jul 1971. 106p. (In French). Dep. NTIS (U. S. Sales Only).

The solidification process was studied by adding a tracer to the liquid metal. A model was developed from the results for a small uranium ingot cast in a graphite mold. The effect of temperature on the vertical and transverse solidification was investigated by observing the profile of the solidification fronts in a number of tests. A thermal gradient in the mold makes the transverse solidification negligible and leads to a solidification front normal to the axis of the ingot. The casting of a uranium hemisphere in a graphite mold was studied using this method and the corresponding isochrones at the solidification temperature determined. (France)

9707 (INIS-mf-60) FUEL RODS ARC WELDING FOR NUCLEAR REACTORS. de Vedia, L. A.; Gutierrez, R.; Mazza, J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 18p. (In Spanish). INIS.

The operations and equipment involved in the welding of fuel

rods of the Zircaloy/UO_2-type for use in pressurized heavy water reactors are described. The developments which were necessary to adapt the arc welding method under inert atmosphere to weld the Zircaloy-4 were emphasized. A program for the automatic control of the welding was one of the most significant developments. (tr-auth)

9708 (LA–4841) ADVANCED PLUTONIUM FUELS PROGRAM. Quarterly Status Report, July 1–September 30, 1971. Baker, R. D. (comp.) (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 20p. Dep. NTIS.

Research on fast reactor fuels is reported on equipment development, hot cell facility at DP West, and methods of analysis. Work on Pu fuels is reported on irradiation testing, and fuel property measurements. Other work is reported on boron carbide chemical analysis and chemical analysis of LMFBR/FFTF fuel. (J.R.D.)

9709 (RFP–1743) MACHINING STUDY OF A URANIUM–4 WEIGHT PERCENT NIOBIUM ALLOY. Fuller, John E.; Lynch, John K. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 17 Nov 1971. Contract AT(29-1)-1106. 17p. Dep. NTIS.

A machining study was made of a uranium–4.3 weight percent niobium alloy. Tool force and surface finish were determined as functions of six machining and tool-geometry variables. Parameters investigated were nose radius, top rake angle, front clearance angle, feed rate, surface speed, and depth of cut. Variables were changed according to an experimental plan dictated by statistical considerations. With each new combination of variables, tool force and surface finish could be observed. Two empirical equations, one for tool force and one for surface finish, have been derived as functions of the independent variables. Advantageous tool-force minima were observed in surface speed and feed rate. Using mathematical models, optimum machining conditions have been developed for rough and finish cuts. (auth)

9710 (RFP–1744) MACROEXAMINATION OF URANIUM ALLOYS. Jackson, Ross J.; Lucas, Robert L.; Calabra, Arthur E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 29 Nov 1971. Contract AT(29-1)-1106. 7p. Dep. NTIS.

Two procedures for macroetching uranium-base alloys are described. The first procedure consists of electropolishing followed by immersion etching in a HNO_3–HAc solution. This procedure is ideal for large nonflat specimens. The second procedure is one of mechanical grinding followed by a vibratory polish-attack macroetch. This procedure is ideal for macropatterns that are difficult to develop. Photomacrographs of uranium alloy castings and forgings prepared in this manner are presented as are the limitations of the procedures. (auth)

9711 SPIKING IN PARTIAL PENETRATION: ELECTRON BEAM WELDS. Armstrong, R. E. (Univ. of California, Livermore). pp 179-94 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

Irregularities in the roots of partial-penetration electron-beam welds are called spikes. A study was made to determine the effect of machine parameters on spiking in depleted uranium, in order to develop a welding procedure that would give maximum penetration with minimum spiking. The joint design used was a straight butt weld without a step and no backing, and photographs of each weld were made. In the study of heat input, it was found that voltage, current, and work travel speed changes have little effect on spiking when the same depth of penetration is maintained. The focus level and beam rotation were also varied with the same results, the spiking increasing with penetration. It is concluded that spiking is a direct function of power density; reducing the power density will reduce spiking but reduces penetration as well. A study of beam focusing was also made, and a method for determining focus is given. (D.L.C.)

9712 TECHNICAL STUDY CONCERNING ELECTRON BEAM WELDING OF BUGEY I REACTOR FUEL ELEMENTS. Marquet, Marc (CEN, Cadarache, France); Michel, Marcel; Savornin, Bernard. pp 232-47 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

Electron beam welding has been selected for the natural uranium magnesium canned fuel element assembly of the CO_2-cooled and graphite-moderated BUGEY I reactor. Problems came from the electron beam welding process (vacuum, accurate beam position) and beam characteristics (low fusion temperature, high thermal conductivity, heterogeneous geometries, nondestructive processes, control tightness, health, penetration, etc.). (auth)

9713 RECENT DEVELOPMENTS IN ELECTRON BEAM WELDING OF UNALLOYED STEELS. Steffens, H. D.; Sepold, G. H. (Arbeitsgruppe fuer Angewandte Materialforschung, Bremen). pp 281-93 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

The electron-beam welding of unalloyed structural steel is attended by a multiplicity of metallurgical problems which are due to the unusually high intensity involved in this process. This intensity produces steep temperature gradients across the weld seam, high internal welding stresses and, in dependence upon the carbon content, embrittlement resulting in a joint with inadequate mechanical-technological properties. The procedures proposed to solve these problems involve preheating and post-heat treatment of the workpieces. Welding with thin interlayers of pure iron is discussed and, finally, a new technique of applying interlayers by metal spraying is proposed with a view to improving the economy of the electron-beam welding process as applied to unalloyed structural steels. (auth)

9714 ELECTRODEPOSITION OF IRON–TUNGSTEN ALLOYS FROM PYROPHOSPHATE ELECTROLYTES. Zayats, A. I.; Perekhrest, N. A. J. Appl. Chem. USSR(Engl. Transl.); 44: No. 6, 1286-91(Jun 1971).

Translated from Zh. Prikl. Khim.; 44: No. 6, 1266-72(Jun 1971).

Investigations of the deposition of alloys of tungsten with nickel or cobalt from ammoniacal and ammoniacal–hydroxyacid electrolytes have revealed certain relationships of simultaneous discharge of these metals during codeposition. Pyrophosphate electrolytes have been widely used in recent years for deposition of metals and alloys. The possibility of depositing iron–tungsten alloys from such electrolytes has been noted in the literature. The effects of the composition of the solution and of the electrolysis conditions on the composition of iron–tungsten alloys and on current efficiency were studied. Certain aspects of the kinetics of alloy deposition were also investigated. It was found that at a constant concentration of one of the codeposited metals in solution the content of the second metal in the alloy increases with its concentration in solution; the current efficiency for the alloy falls with increasing tungsten content in the alloy; the current efficiency for the alloy is considerably higher with sodium bicarbonate as the buffer additive in comparison with ammonium carbonates, while the alloy composition is altered but slightly; and increase of temperature raises the current efficiency substantially without altering the alloy composition. Increase of current density from 10 to 100 mA/cm^2 results in a considerable increase of the iron content in the alloy but has little effect on current efficiency. It was also found that electrodeposition of iron–tungsten alloy is accompanied by depolarization relative to the calculated standard potential of tungsten and relative to the discharge potentials of hydrogen and iron. (R.C.K.)

9715 METHOD OF PREPARATION OF LaB_6 CATHODES. Nasini, M.; Redaelli, G. (CISE, Milan). Rev. Sci. Instrum.; 42: No. 12, 1765-7(Dec 1971).

A technique for preparation of cathodes consisting of a tantalum LaB_6 coated ribbon has been successfully tested. The cathode has shown good performances in high-density gas discharge tube (as ion lasers) operations. (auth)

9716 PROCESS FOR PRODUCING DISPERSION-HARDENED SUPERALLOYS BY INTERNAL OXIDATION. Hammond, Joseph P.; Chang, Ji Young (to United States Atomic Energy Commission). U. S. Patent 3,615,381. 26 Oct 1971. Filed 13 Nov 1968.

Iron-, nickel-, and cobalt-base alloys containing chromium in an amount sufficient to provide excellent scaling resistance to high temperature are made pervious to controlled quantities of oxygen by alloying with an appropriate amount of a metal selected from thorium, yttrium, or one of the rare earth (4f) metals to form a lamellar eutectic structure. Powders of these alloys are roasted in air to pick up oxygen, then cold compacted and sintered to consolidate the mass while at the same time allowing diffusion of oxygen to form a uniform and ultrafine dispersion of stable oxide particles. Subsequent hot mechanical working shapes and further consolidates the alloy while improving the distribution of metal oxide particles. (Official Gazette)

9717 COLD MACHINING HIGH-DENSITY TUNGSTEN. Ziegelmeier, P. J. Cutting Tool Eng.; 23: No. 5, 11-13(May 1970).

Coolants at a subzero temperature were used in machining trials on high-density W. Turning, boring, threading, and drilling operations were performed on a rigid lathe protected by polyethylene

sheeting from the corrosive action of the trichloroethylene coolant. Tooling is of tungsten carbide, kept sharp with diamond wheels of 180-mesh diamond or finer. Other materials, including TZM, Nicrotung, thoriated W, Mo 70–30 W, Ta, and Inconel X-750, also were machined with greater ease using the sub-zero coolant. (Metals Abstr.)

9718 CONTROLLING MICROSTRUCTURES AND PROPERTIES OF SUPERALLOYS VIA USE OF PRECIPITATED PHASES. Muzyka, Donald R. (Carpenter Tech. Corp., Reading, Pa.). Metals. Eng. Quart.; 11: No. 4, 12-20(Nov 1971).

A review of fundamental aspects of the processing of wrought superalloys—with major emphasis on structure control effects available from precipitating phases is presented. Basic methods are suggested to process various superalloy compositions to nearly identical microstructures and property levels by utilizing solvus relationships of precipitating phases in selecting working and heat treating cycles. Structure control procedures are most useful to produce best tensile, impact, fatigue and low cycle fatigue properties from 70 to about 1,200°F for most superalloys. For Type I alloys, the γ' phase is paramount as a structure controlling phase—and attendant characteristics involving use of processing and heat treating temperatures in the vicinity of the γ' solvus are critical. Most flexibility in processing Type I alloys is achieved with alloys containing high volume fractions (>40) of γ' in the alloy. For Type II alloys, a "third phase" (such as Ni_3Ti or Ni_3Nb) in addition to the γ' can be used to "pin" grain boundaries. Most flexibility in processing is achieved in alloys with a wide separation between γ' and Ni_3X solvus temperatures, a high volume fraction of γ' and Ni_3X, and the highest possible temperature for an Ni_3X solvus. It is suggested that superalloy metallurgists seriously consider utilizing a division of precipitation, hardening alloys into the Type I and Type II categories discussed here. For the future, it is believed that structure control will grow in importance as metallurgists strive to attain best properties in the most economical alloys. (auth)

9719 BERYLLIUM. Gelles, S. H.; Ashurst, A. N. DMIC Rev.; 6p(27 Nov 1970).

Studies on the fabrication of Be include those on shear spinning, spark machining, plating, composites, plasma consolidation, and low-temperature bonding. References are made to microyield strength, high-pressure flow, deformation textures, and mechanical properties. Powder-metallurgy developments include fine-grained forgeable grades of Be (test data on forged disks are given). Described are hot pressing mechanisms and the "Hip and Roll" process, a combination of hot isostatic compaction and rolling used to fabricate integrally stiffened structures. New research programs are listed. (Metals Abstr.)

9720 NICKEL- AND COBALT-BASE ALLOYS. Beuhring, V. F.; Simmons, W. F.; Drennan, D. C. DMIC Rev.; 6p(4 Nov 1970).

Recent research on these superalloys includes work on: compressive and yield-strength data for Incoloy 802 and hot hardness data for Incoloy 800 and 802 and Inconel 625 and X-750; the production of high-quality Unitemp AF2-1DA sheet by extrusion and rolling; bend, fatigue and elevated-temperature tensile properties of a Co–25W–3Cr–1Ti–0.5Zr–0.5C alloy for high-temperature applications; melting, casting, physical metallurgy and mechanical properties of Ni–Ti alloys possessing a mechanical memory; advanced wrought Ni alloys for turbine disk applications; tensile and fatigue properties and alloying and oxidation behavior of a Ni_3Al–Ni_3Nb alloy; the strength of Ni–Mo–ThO_2 alloys in sheet form at 2000°F; the effect of S content in fuel on the hot corrosion of turbine-blade alloys; processes for chromizing and aluminizing TD–Ni; the oxidation-erosion resistance of three commercial diffusion coatings on two Ni- and Co-base superalloys under simulated gas-turbine operating conditions at 2050°F; and coating compositions and laboratory-scale processing techniques for field repair of damaged aluminide diffusion coatings on Ni-base turbine-blade alloys. (Metals Abstr.)

9721 IRON AND STEEL MATERIALS FOR PRESSURE VESSELS IN NUCLEAR POWER PLANTS. Nomura, Junichi (Japan Steel Works, Ltd., Tokyo); Oda, Toyohisa; Onouchi, Yoshikazu. Kinzoku Zairyo; 11: No. 6, 77-84(Jun 1971). (In Japanese).

Development of hydraulic and conventional steam power generation becomes more and more difficult, and nuclear power generation is promoted rapidly in view of prevention of pollution and economy. In iron and steel materials for the nuclear power generation, safety regarding their quality takes highest priority. The required quality level, applied inspection details, and exactitude are given consideration according to various laws and standards. Transition of pressure vessel steels from initial ASTM A201 and A212 steels to present A533gr B steel for plates and A508 C12 steel for forgings is described and ASME and ASTM standards are quoted. The steel materials required for power generating reactors became large and thick as power output of 1,000 MW is being realized in foreign countries and Japan. No harmful internal defects, good weldability and workability, superior notch toughness, high high-temperature strength, creep strength, fatigue strength, corrosion resistance, and minimum induced radioactivation and neutron irradiation damage must be guaranteed for the materials. Effects of cooling rate, heat treatment conditions, chemical composition, and past-heating toughness must be taken into full consideration. Detection of internal defects is accomplished by nondestructive tests. Japan produces almost all steels for domestic power generating reactors and exports large castings, forgings, plates, and pipes. (Japan)

9722 CATHODIC DEPOSITION OF VARIOUS TRANSITION METALS FROM ORGANIC SOLVENTS ON A PLATINUM MICROELECTRODE. II. Byallozor, S. G. Elektrokhimiya; 6: No. 12, 1831-4(Dec 1970). (In Russian).

As a continuation of the study of the electrodeposition of Co, Cd, Zn, Cu, and Ni from organic solvents (acetonitrile, dimethylformamide) on a Pt microelectrode, the corresponding systems were further examined by the rapid-polarization technique (ibid., 1968, 4, 993). The low rate of deposition of these metals from the solvents in question was traced to the adsorption of complex ions or particles of the organic solvent on the Pt electrode surface. (Metals Abstr)

9723 NEW METHOD FOR EVALUATING STRENGTH AND DUCTILITY OF BRAZED JOINTS. Klausnitzer, E. (Siemens Aktiengesellschaft, Erlanger, Ger.). Weld. J. (N. Y.); 50: No. 10, 454s-60(Oct 1971).

Results of investigations of a universal type of braze specimen are presented. It is noted that experience gathered with brazed specimens and the new testing methods for evaluating the shear strength and ductility of brazed joints are predominantly good. The great advantages of the brazed specimen are easy and cheap production and good reproducibility as well as good maintenance of the brazing gap. It should further be emphasized that a brazing fixture is not required. Slices cut from the brazed specimen are advantageous in that they were brazed under exactly the same conditions. Any undesirable marginal conditions are therefore eliminated from the subsequent examinations. The slices are well suited for many testing methods. (auth)

9724 WHISKER GROWTH FROM THIN EVAPORATED CADMIUM FILMS. Neumann, H.-G. (Univ., Rostock, Ger.). Thin Solid Films; 8: No. 5, R55-8(Nov 1971).

Whisker growth from very thin Cd films with relatively simple structure was studied by transmission and replica electron microscopy. The dependence of whisker density on film thickness is shown. The results show that the growth of whiskers occurs by grain growth or recrystallization, with the energy for the growth being derived from stresses. (D.L.C.)

9725 CONTINUOUS VACUUM CASTING METHOD FOR METALS OR OTHER PRODUCTS. Chaulet, Roger; Guichard, Claude; Menissier, Pierre; Soret, Jean Claude. (to Societe Industrielle de Combustible Nucleaire). French Patent 2,063,100. 9 Jul 1971. Filed 15 Sep 1969. (In French).

This equipment consists of an ingot mold, which is fed under vacuum with liquid materials using an input device regulated by a servomechanism controlled by a level detector. The ingot mold is provided with a vertical alternating vibratory motion using two rods driven by a motor. The level detector, which functions independent of the motion of the mold, and is under vacuum, consists of a Geiger tube parallel to the axis of the ingot mold and a radioactive source arranged in such a way that the Geiger tube receives the radiation axially. (France)

9726 CHARACTERISTICS OF THE CATHODIC PROCESS IN ELECTRODEPOSITION OF NICKEL–RHENIUM ALLOYS. Pishikin, A. M.; Popereka, M. Ya. (Pedagogic Inst., Kalinin, USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 5, 1024-7 (May 1971).

Translated from Zh. Prikl. Khim.; 44: No. 5, 1015-20(May 1971).

Results of studies of cathodic polarization during electrodeposition of Re–Ni alloy are presented which show that the form of the potentiokinetic polarization curves for deposition of rhenium and rhenium–nickel alloy on a solid cathode is determined mainly by the relationships of hydrogen evolution. The curves for deposition of the alloy have a step corresponding to the limiting diffusion current of hydrogen. The subsequent increase of the current is due to discharge either of ammonium ions or water molecules. In the latter case ammonium ions activate the cathode surface. Both rhe-

nium and nickel are deposited in alloys with depolarization. High current densities (20 A/dm^2 and over) are needed for deposition of alloys rich in nickel; elevated temperatures (70°) are required for high overall current efficiencies for the alloy (90% and higher). (auth)

9727 GAS-SHIELDING TECHNIQUES FOR WELDING TITANIUM. Wright, Robert. Weld. Eng.; 55: No. 11, 50, 52, 54, 56(Nov 1970).

Commercially pure Ti and the alloys Ti–5Al–2, 5Sn, Ti–6Al–4V, Ti–8Al–1Mo–1V, Ti–6Al–6V–2Sn, and Ti–13V–11Cr–3Al are easily welded by Tig, Mig, plasma-arc, and electron beam processes. Careful shielding is required to prevent embrittlement by O, N, or H. Hard, or fixed, chambers have been used for a long time for many types of materials. Soft chambers of polyethylene film with heat sealed or taped seams are used for short production runs, weld repairs, and complex shapes. Weld tooling is used in out-of-chamber techniques to contain and distribute the shielding media. Several methods of this type of shielding are illustrated. (Metals Abst.)

9728 U BASED ALLOY AND THE PROCESS FOR MANUFACTURING THIS ALLOY. (to Commissariat a l'Energie Atomique). French Patent 2,052,024. 29 Mar 1971. Filed 7 Jul 1969. (In French).

A U based alloy envisaged as a metallic nuclear fuel is discussed. It has the following composition: 0.05 to 0.2% Nb, 0.02 to 0.06% Fe, 0.02 to 0.06% Si, and 0.02 to 0.12% C, the remainder consisting of U and impurities. The mechanical properties obtained are satisfactory (very fine grain, numerous precipitates with homogeneous distributions). A relatively small quantity of elements is added and the neutron cross sections of these elements are lower than that of Mo which has been used previously. (France)

9729 CONFIRMATION TESTS ON METHOD OF FABRICATING LEAD SHIELDS. Kawai, Yasuhiko; Fujikawa, Masahiro (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 86, 2144-53(Dec 1970). (In Japanese).

In the nuclear ship Mutsu, lead blocks are used as secondary shields, amounting to about 1/4 of light weight of the ship. The blocks are on top of a reactor containment vessel and are a part of platform deck. The blocks are produced in the factory and assembled into the shield in the ship. The procedure for producing each block includes pretreatment of a casing, casting of lead into the casing, and finishing. Results of confirmation tests on the preparation of the lead blocks are described as follows: occurrence of cavities; adherence of lead to the casing; finished accuracy of the blocks; gap filling between the blocks; specific gravity of the lead in the blocks; finished surface of welding for the blocks; improvement on the gap-filling work; and improvement on the casing. (Japan)

9730 ION-CURRENT CHARACTERISTICS IN THE ELECTRON-BEAM ZONE MELTING OF MOLYBDENUM. Brodskii, I. A.; Petushkov, E. E.; Mikhailov, S. M. pp 137-42 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

Phenomena associated with the ionization of gases evolved from the molten zone of the metal in the zone melting of Mo are considered; a relationship is derived between the ion current, as measured by a special technique, and the quantity of gas evolved from the metal. By analyzing the ion-current distribution and converting to gas evolution, an explanation is secured for the nonuniformity often found in the crystal structure of Mo single crystals grown by the zone-melting method. The nonuniformities essentially arise from the instability of the thermophysical conditions prevailing. (Metals Abstr.)

9731 ELEMENTS OF ENERGY CALCULATION OF ZONE MELTING AT HIGH TEMPERATURES. Tserfas, A. A.; Petushkov, E. E. pp 148-52 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The energy requirements associated with the zone melting of refractory metals (Mo,W, Nb, etc.) are analyzed theoretically. Relationships are derived between the width of the molten zone, the power supplied by the source, the geometrical dimensions of the system, and the thermophysical properties of the material in question at high temperature. These relationships are too complex for practical use in general form; however, by carrying out a series expansion and making reasonable approximations, a tractable equation agreeing with existing empirical formulae is secured. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 9086, 9136, 9171, 9202, 9294, 10317, 10320, 10321, 10326, 10330, 10332, 10338, 10351, and 11345.

9732 (CNEA-TE-1-27) ZIRCONIUM PHYSICAL PROPERTIES. ZIRCONIUM PROGRAM: SUMMARY OF INFORMATION. Serebrinsky, J. H. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 17p. (In Spanish). INIS.

Data on the thermal and thermodynamic properties and on the electrical and mechanical properties of Zr are summarized. The electron structure and the alloying theory are discussed. (tr-auth)

9733 (ORO-2907-81) EMISSIVITIES OF LIQUID METALS AT THEIR FUSION TEMPERATURES. Bonnell, D. W.; Treverton, J. A.; Valerga, A. J. (Rice Univ., Houston, Tex. Dept. of Chemistry). [1970]. 12p. (CONF-710604-4). Dep. NTIS.

From fifth symposium on temperature; Washington, D. C. (21 Jun 1971).

A survey of the literature through 1969 showed an almost total lack of experimental emissivity data for metals in the liquid state. The emissivities for several transition metals and various other metals and compounds in the liquid state at their fusion temperatures have been measured. The technique used involves electromagnetic levitation-induction heating of the materials in an inert atmosphere. The brightness temperature of the liquid phase of the material is measured as the material is heated through fusion. Given a reliable value of the fusion temperature, which is available for most pure substances, emissivity may be readily calculated for the liquid phase at the fusion temperature. Even in cases where melting points are poorly known, the brightness temperatures are unique parameters, independent of the temperature scale and measured for a chemically defined system at a fixed point. Better emissivities may be recalculated as better melting point data become available. (auth)

9734 (RD/B/N-2098) RATE CONTROLLING NUCLEATION AND DIFFUSION PROCESSES IN FACETED INERT GAS BUBBLES AND VOIDS. Beere, W. B.; Reynolds, G. L. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sep 1971. 13p. Dep. NTIS (U. S. Sales Only).

Electron microscope observations of inert gas bubbles in thin foils of high-purity copper annealed under a hydrostatic pressure of 143 MN/m^2 at 600°C for 30 min showed that vacancies are emitted preferentially from certain faces. A nucleation model is presented which explains the phenomena by considering the relative ease of nucleating atomic layers on different faces when the bubble is intersected by a dislocation. The nucleation model is extended to consider the rate of approach to equilibrium of asymmetric gas bubbles and the annealing of voids. (auth)

9735 (UCLA-34-P-177-7) VANADIUM ALLOY DEVELOPMENT. Quarterly Progress Report [for Period Ending June 30, 1971]. Tetelman, A. S.; Ardell, A. J.; Ono, K. (California Univ., Los Angeles. Dept. of Materials). Aug 1971. Contract AT-(04-3)-34. 13p. Dep. NTIS.

Results of research on strengthening of vanadium alloys are included in an abstract of a thesis which is not yet available. Other work is reported on structure and strengthening of Croloy, and precipitation reactions in stainless steel. (J.R.D.)

9736 INFLUENCE OF PROCESSING HISTORY ON THE MECHANICAL BEHAVIOR OF A Zn–W COMPOSITE. Edwards, Glen R.; Sherby, Oleg D. (Stanford Univ., Calif.). Int. J. Powder Met.; 7: No. 4, 21-33(Oct 1971).

A 28 vol % W–Zn composite was prepared from 30 μ zinc powder and 1 μ tungsten powder by a powder metallurgy technique involving sequential extrusions and rollings. The effects of processing on the character of the composite were evaluated by metallographic examination and by subjecting samples representing four stages of the processing to room temperature compression and tensile tests. The composite was observed to become progressively weaker and more ductile as the microstructure was homogenized by processing. (auth)

9737 POWDER-METALLURGY SUPERALLOY STRENGTHENED BY A γ'' PHASE. Kotval, P. S. (Union Carbide Corp., White Plains, N. Y.). Int. J. Powder Met.; 7: No. 4, 37-44 (Oct 1971).

Argon-atomized prealloyed powders of a nickel-base superalloy composition, which is precipitation-strengthened by the body-centered-tetragonal γ'' Ni_3Ta phase, have been consolidated by extrusion. Subsequently, thermomechanical and aging treatments caused this powder metallurgy superalloy to exhibit high strength at 1200°F without loss of ductility. Thin foil microscopy observa-

tions of the microstructure were correlated with the mechanical properties. (auth)

9738 TECHNIQUE FOR STUDYING ALKALI METAL–GAS REACTIONS AT TEMPERATURES UP TO 450°C. Evans, H. E.; Whittingham, A. C. (Berkeley Nuclear Labs., Eng.). J. Brit. Nucl. Energy Soc.; 10: No. 4, 334-6(Oct 1971).

A technique for studying the reactions between liquid alkali metals and a wide range of gases under isothermal conditions temperatures up to 450°C is described. The reaction vessel u... incorporates a capacitance manometer, a valve for gas admission or removal, an electromagnetic pumping assembly, and liquid metal admission and removal facilities. (auth)

9739 ACTIVATION ENERGY FOR THE MOTION OF DISLOCATIONS IN MOLYBDENUM. Agnihotri, O. P. (Indian Inst. of Tech., New Delhi). Phys. Status Solidi (a); 7: No. 1, K33-4 (16 Sep 1971).

The activation energy of recovery in cold-worked Mo was obtained at 600, 627, and 650°C from measured x-ray diffraction line shapes. The width of the $K\alpha_1\alpha_2$ doublet was used as a measure of the broadening. The plot of ln annealing time vs 1/T gives 2.4 eV as the activation energy. (D.L.C.)

9740 CALCULATION OF SOLUBILITY LIMITS IN DILUTE BERYLLIUM ALLOYS. Ausloos, M.; Lalevic, B. (Temple Univ., Philadelphia. Franklin Inst., Philadelphia). Phys. Status Solidi (a); 7: No. 1, K51-3(16 Sep 1971).

Solubility limits and phase stability of dilute Be alloys were calculated using the pseudopotential theory of metals. The band structure energy U_{BS} was calculated for Be–Cu alloys as a function of the axial c/a ratio. There is a Cu concentration where U_{BS} becomes lower than that of pure Be. The absolute solubility limit is 0.04 Cu (at. wt. fraction) from a plot of ΔU_{BS} vs x. The c/a ratio for Be–Cu alloys moves toward lower values. Similar results were obtained for Be alloys with Ag; Au was calculated to be insoluble in Be. The hcp phase is calculated to be stable against change to the fcc structure. (D.L.C.)

9741 GRAIN-BOUNDARY DIFFUSION OF MOLYBDENUM IN TUNGSTEN. Butz, R.; Erley, W.; Wagner, H. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi (a); 7: No. 1, K5-8(16 Sep 1971).

W single-crystal rods were cut, the (110) and (111) faces were connected by diffusion bonding, and the couple was cut perpendicular to the bonded interface. Thus, specimens with one planar incoherent grain boundary perpendicular to the surface were obtained. Mo layers were evaporated onto the surfaces, and diffusion runs were made at 1840, 1960, and 2090°C for 100 and 200 hr. Cuts perpendicular to both surface and grain boundary were made and the Mo profile determined by electron microprobe analysis. A plot of the integrated Mo content vs the 6/5 power of the penetration depth showed linear curves for the 2090 and 1840°C runs, with grain boundary movement occurring at 1960°C. The grain boundary diffusion coefficient was determined to be 3.8×10^{-7}, 6.7×10^{-7}, and 7.6×10^{-7} cm²/sec at 1840, 1960, and 2090°C, respectively, for a grain boundary thickness of 5 Å. The activation energy is 27 Kcal. (D.L.C.)

9742 POROSITY OF CHROMIUM–TUNGSTEN METAL FUSED UNDER NITROGEN. Razikov, M. I.; Korolev, N. V.; Zubkov, N. S. Avtomat. Svarka; No. 11, 39-40(Nov 1971). (In Russian).

A Cr–W steel, Type 3X2B8 (composition not given) was fused under nitrogen. Aluminum was introduced in the form of FeAl containing 65% Al. Alloying with nitrogen was accomplished by feeding the gas through the hot zone of an electric arc. The addition of Al reduced the porosity; as little as 0.25% Al resulted in zero porosity. The concentration of nitrogen was studied as a function of arc voltage, welding current, and welding rate. (K.S.W.)

9743 NONMETALLIC INCLUSIONS IN WELDED STEEL JOINTS CONTAINING TITANIUM AND CERIUM. Lysenko, N. I.; Kovalev, Yu. Ya.; Grabin, V. F.; Novikov, I. V. Avtomat. Svarka; No. 11, 69-71(Nov 1971). (In Russian).

The effects of Ti and Ce on steel were investigated for the case where Ti and Ce were introduced for the purpose of capturing low-melting impurities. The composition was of course altered, and nonmetallic inclusions were reduced. The removal of low-melting sulfides by the formation of refractory compounds was of special importance. It was concluded that by reducing the quantity of such nonmetallic occlusions and/or introducing elements which would form refractory compounds with harmful impurities, undesirable stress cracking should be inhibited. (K.S.W.)

9744 DIFFUSION PROCESSES. VOLUME I. Proceedings of the Thomas Graham Memorial Symposium, Strathclyde, Scotland, September 22–24, 1969. Sherwood, John N. (ed). London; Gordon and Breach Science Publishers Ltd. (1971). 395p. £12.25. (CONF-690936–(Vol. 1)).

Forty nine papers were presented at the symposium 25 of which are included in Vol. I. A separate abstract was prepared for each of two papers that were in scope for NSA. (UK)

For abstracts of individual papers see: 9745 and 9746.

9745 SELF-DIFFUSION AND THE DIFFUSION MECHANISM IN bcc TRANSITION METALS. Neumann, G. M. (OSRAM-Studiengesellschaft, Munich). pp 329-60 of Diffusion Processes. Vol. I. /Sherwood, John N. (ed.). London; Gordon and Breach Science Publishers Ltd. (1971).

From Proceeding of the Thomas Graham memorial symposium; Glasgow, Scotland (22 Sep 1969).

Self-diffusion in bcc transition metals is reviewed and a simple theory for diffusion in these metals is proposed. Literature data are critically re-analyzed and appropriate Arrhenius parameters evaluated. In order to check the data, vacancy and divacancy properties for bcc metals were estimated on the basis of an appraisal of the corresponding point defect properties of fcc metals. It was found that non-linear Arrhenius relationships in the metals of the Vth and VIth sub-groups–V, Nb, Ta, Cr, Mo, W–are consistent with a mechanism of vacancy-divacancy diffusion. Non-linear Arrhenius relationships in the metals of the IVth sub-group–Ti, Zr, Hf–can then be attributed to a more complex mechanism of diffusion including short-circuit and dislocation contributions. (auth)

9746 SOLUTE DIFFUSION IN α–Zr. Hood, G. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 361-72 of Diffusion Processes. Vol. I. /Sherwood, John N. (ed.). London; Gordon and Breach Science Publishers Ltd. (1971).

From Proceedings of the Thomas Graham memorial symposium; Glasgow, Scotland (22 Sep 1969).

Measurements of diffusion of ^{64}Cu in single crystals of α-Zr were made in the temperature interval 720 to 835°C. They showed diffusion rates for Cu that are about four orders of magnitude faster than self diffusion. This result suggests that α-Zr may be one of a number of metals capable of exhibiting extremely fast interstitial-like solute diffusion. In addition, single diffusion measurements of ^{65}Zn, ^{110}Ag, ^{113}Sn, and ^{198}Au in α-Zr single crystals were made between 821 and 840°C. The results of these experiments, in combination with the results for ^{64}Cu, indicate that, in α-Zr, solutes of low valence and small "size" diffuse more rapidly than solutes of high valence and large "size". (auth)

9747 DIFFUSION PROCESSES. VOLUME II. Proceedings of the Thomas Graham Memorial Symposium, Strathclyde, Scotland, September 22–24, 1969. Sherwood, John N. (ed.). London; Gordon and Breach Science Publishers Ltd. (1971). 827p. £12.25. (CONF-690936–(Vol.II)).

Forty nine papers were presented at the symposium, 24 of which are included in Vol. II. A separate abstract was prepared for one paper that was in scope for NSA. (UK)

For an abstract of an individual paper see: 9865.

9748 STUDY ON STEEL FOR REACTOR PRESSURE VESSELS. ASTM-A543 STEEL AND ITS WELDING MATERIALS. Sakakihara, Mizuo; Yoshimura, Hirofumi (Nippon Steel Corp., Kitakyushu, Japan). Karyoku Hatsuden; 22: No. 2, 200-7(Feb 1971). (In Japanese).

As the output of nuclear power plants becomes greater, large reactor pressure vessels requiring ASTM-A533 steel heretofore in use for RPV doesn't sufficiently satisfy this requisite. Therefore studies on A543 steel which seems to be effective for reduction of wall thickness were undertaken concerning its heat treatment properties, proper contents of carbon and vanadium for 200 mm-thick steel plates, and wires for submerged arc welding. Five kinds of A543 steel were used and tested by the simulated heat treatment method concerning effects of C and V additions on their strength and toughness. A543 steel is qualified for extremely thick steel plates, and 200 mm thick plates need 0.17% or more carbon or addition of vanadium. Eleven kinds of welding materials were used and welded with an electric arc. Strength and toughness of welded steels after stress relief were tested and the effects of Cr and Cu are discussed. The toughness of A543 steel deteriorated under stress relief. A good welding material for A543 steel was found to be 5Ni–1.0Cr–0.5Mo–0.05V. The properties of joints made by submerged arc welding of A543 steel were tested concerning strength and toughness in terms of welding heat input. The joints can satisfy standards even when they are welded with large heat input of 67KJ/cm. (Japan)

9749 METALLIC MATERIALS FOR NUCLEAR POWER REACTORS. Nagai, Nobuyuki (Kobe Steel, Ltd., Japan). Sangyo Kikai; No. 243, 67-73(Dec 1970). (In Japanese).

Metallic materials developed by the growth of the atomic energy industry, especially new core materials and latest products for power reactors are described, while production methods and properties of each product are discussed on the basis of practical experience in production experiments. The present status of their domestic production is summarized. Details are as follows: classification and characteristics of reactor materials, reactor types and core metallic materials, Zircaloy cladding tubes for light-water-type power reactors, channel boxes for BWRs, stainless steel cladding tubes for nuclear-powered ships, pressure tubes and calandria tubes for advanced thermal reactors (ATR), and stainless steel cladding materials and wrapping wires and wrapper tubes for fast breeders. (Shida, Y.) (Japan)

9750 THERMAL STUDY OF THREE In–Tl ALLOYS IN THE NEIGHBORHOOD OF THE fct–fcc TRANSFORMATION: HEAT CAPACITIES FROM 5 TO 300°K. Schwartz, Robert G.; Gerstein, B. C. (Iowa State Univ., Ames). J. Chem. Phys.; 55: No. 8, 4034-48(15 Oct 1971).

The heat capacities of three In–Tl alloys, having compositions of 34.6-, 28.9-, and 18.8-at.% Tl, were measured from 5 to 300°K. The thermodynamic functions were tabulated. In this temperature range, the 28.9-at.% Tl alloy exhibited a martensitic transformation from fct to fcc. The 34.6-at.% Tl alloy remained fcc and the 18.8-at.% Tl alloy remained fct. The entropies at 298°K were found to be 61.6 ± 1.6, 61.4 ± 2.0, and 61.1 ± 1.6 J (gaw · deg)$^{-1}$ for the three alloys, respectively. The alloy that transformed from fct to fcc exhibited deviations from smooth behavior in the heat capacity in the region of the transformation. While no alloy exhibited anomalous behavior below 195°K, all alloys exhibited anomalous 5% to 8% rises in heat capacity above 195°K. This behavior was exhibited over a 25° to 35° range, depending on the alloy composition. This rise in heat capacity was irreversible in the 28.9- and 34.6-at.% Tl alloys, but reversible, to within experimental error, in the 18.8-at.% Tl alloy. The behavior correlated with anomalous thermal expansion coefficients of fcc and fct alloys reported by previous investigators. (auth)

9751 RESISTOR MATERIALS, 1971. Conrad, Paul. Chemical Process Reviews. Park Ridge, N. J.; Noyes Data Corporation (1971). 224p. $35.00.

Techniques for producing resistor materials are described. Information is included on metals and other elements, alloys, cermets, oxides, nitrides, sulfides, silicides, carbides, and organic compositions. (J.R.D.)

9752 ELECTRIC PROPERTIES OF A BED OF ANODIC OXIDE FORMED ON URANIUM WITH CONTROL POTENTIAL IN MEDIUM AT pH 13. Jouve, G. (Univ. de Paris, Orsay, France). J. Nucl. Mater.; 41: No. 2, 221-6(Nov 1971). (In French).

The electrical properties of an anodic oxide layer formed on uranium was studied by applying an electric field, both direct current and alternating current, parallel to the smallest dimension of the oxide layer. The results indicated that in the $UO_3 \cdot 2H_2O$ layer there was simultaneously an electron conduction and an ionic type conduction which results in the appearance of an interfacial polarization. The electron conduction was connected to the cracking of the oxide layer under certain conditions. (J.S.R.)

9753 FORGEABILITY AND WELDABILITY OF HIGH BORON STEELS. Shigematsu, Ishige; Obara, Ryukichi (Mitsubishi Steel Mfg. Co. Ltd., Nagasaki). Mitsubishi Seiko Giho; 5: No. 1, 11-22(Feb 1971). (In Japanese).

Hot workability, weldability, and mechanical properties of high boron steels used as control rod and shield materials for nuclear reactors were investigated. In the melting practice, great care should be taken to prevent corrosion of furnace linings by high boron addition. Hot workability of boron steel ingots is decreased by the increase of boron content and ingot size, but the addition of titanium of about two times the boron content improves it. By this procedure, high boron steel ingots can be successfully hot worked as in the case of low boron steel ingots. Ductility and toughness of rolled or forged boron steels decrease as the boron content increases. Ductility in tension tests is improved by suitable titanium additions but impact toughness remains at a very low level. Because of the high sensitivity of deposit metal to cracking, the welding of boron steels is difficult; only the ASTM E312-16 welding electrode is acceptable. (auth) (Japan)

9754 USE OF EMF-METHOD FOR DETERMINATION OF THERMODYNAMIC PROPERTIES OF TRANSITION METAL ALLOYS. Meshkov, L. L.; Oleinikov, N. N.; Sokolovskaya, E. M.; Guzei, L. S. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 450-3(Jul-Aug 1971). (In Russian).

The possibility of application of galvanic cells with separate gas space over the electrodes for determination of the thermodynamic properties of the alloys Ni through Mo was studied. (auth)

9755 STRENGTHENING, SOFTENING, AND HEAT STABILITY OF AN ALUMINUM–ZIRCONIUM ALLOY. Zeiger, H. (Vereinigte Deutsche Metallwerke AG, Frankfurt am Main). Aluminium; 47: No. 5, 305-8(1971). (In German).

The influence of an admixture of 0.2% Zr to Al 99.3 on the strengthening and softening behavior and heat stability of foils was investigated. The strengthening was not affected, the softening, or recrystallization temperature, respectively, was increased by the Zr-admixture. The degree of increase was highly dependent on the hot-rolling, or full annealing temperature, respectively. The heat stability was slightly increased by the Zr-addition. A metallographic interpretation of these results will only be possible after the evaluation of electron microscopic structure examinations. (INIS)

9756 DISTINCTION BETWEEN ION DAMAGE AND THE EARLY STAGES OF CARBIDE PRECIPITATION IN NICKEL ALLOYS. Scarlin, R. B. (Brown Boveri Research Center, Baden, Switzerland); Hollox, G. E.; Edington, J. W. J. Mater. Sci.; 6: No. 10, 1322-4(Oct 1971).

The occurrence and characteristics of electron microscope-induced ion damage in a Ni/2 wt % Ti/0.4 wt % C alloy are reported. The recognition of small precipitates in its presence is discussed. (UK)

9757 FRACTURE MECHANICS AND STRESS CORROSION CRACKING: A POSSIBLE RELATIONSHIP BETWEEN K_{Ic} AND $K_{I(scc)}$. Tyzack, C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Brit. Corros. J.; 6: No. 5, 219-23(Sep 1971).

The extent to which the concepts used in linear elastic fracture mechanics can be applied to certain cases of stress corrosion of metals, in particular the concept of crack opening displacement, was considered. It is suggested that in some cases the concept of surface energy in a Griffith-type treatment, and plastic work of fracture in a Griffith–Orowan–Irwin-type treatment can be usefully supplemented by the concept of chemical work of fracture in stress corrosion. For the case where crack growth is purely by localized anodic dissolution, an expression was derived which relates the rate of crack growth to the overpotential of the corrosion cell and the rate of crack opening displacement. (auth)

9758 APPLICATION OF AN ELECTROMAGNETIC CRUCIBLE WHEN MEASURING METAL ENTHALPY. Chekhovskoi, V. Ya.; Berezin, B. Ya. (Inst. of High Temperature, Moscow). Inzh.-Fiz. Zh.; 21: No. 2, 309-12(Aug 1971). (In Russian).

The possibility is shown of using electromagnetic levitation for measuring enthalpy and mean heat capacity of metals by the method of mixing. Molybdenum heat capacity was measured within the temperature range from 2094 to 2684°K. The experimental results are in agreement with the data from the literature. (auth)

9759 EFFECTS OF TITANIUM AND ALUMINUM VARIATIONS ON AN IRON–NICKEL SUPERALLOY. Whitney, C. R.; Krauss, G. (Carpenter Tech. Corp., Reading, Pa.). Metals Eng. Quart.; 11: No. 4, 25-30(Nov 1971).

Pyromet 860 develops excellent tensile properties at 70 to 1,000°F when processing is carefully controlled. Hot working temperature, percentage of hot reduction, and solution temperature for a given hardener level are the parameters which are most important. Highest strengths are obtained when thermomechanical processing is performed at temperatures below the η solvus temperature. Subsequent thermal exposures at temperatures below the η solvus cause profuse η precipitation which acts as a structure controlling phase. That is, it retards grain boundary motion during recrystallization or grain growth (or both), thus indirectly contributing to strengthening. (auth)

9760 DIFFUSION EXPERIMENTS ON RHENIUM-COATED HIGH-MELTING-POINT METALS. Kirner, Kuno (Wissenschaftsministeriums Gefoerdert, Gerlingen, Ger.). Forsch. Ingenieurw.; 37: No. 4, 109-14(1971). (In German).

Following a survey of special properties and applications of rhenium, diffusion experiments were performed on round rods of W, Mo, Nb, and graphite that were covered with rhenium by spray coating. Heating of the metal pairs at 2000°C produces intermetallic compounds in the form of zones, the width of which increases with time according to the $\sqrt{t}$ law. Results are discussed with respect to state diagrams belonging either to the system or

to contradictory ones. In the diffusion pairs rhenium–tungsten and rhenium–molybdenum, σ and χ phases occur, whereas, the pair rhenium–niobium produces a χ phase. If multiple layers of tungsten–rhenium–graphite are exposed to a temperature of 2600°C, layers of WC, W_2C, and the σ phase of the tungsten–rhenium system appear. (tr-auth)

9761 STUDY OF THE FORMATION OF CREEP CAVITIES IN POWDER-METALLURGY TUNGSTEN. Stiegler, James Ottomar. Knoxville, Tenn.; Univ. of Tennessee (1971). 213p. University Microfilms Order No. 71-29,497.

Thesis.

At elevated temperatures metals suffer a loss in ductility brought about by the formation of grain-boundary cracks. Details of the nucleation and growth of these cracks in tungsten produced by a powder-metallurgy process were studied by electron fractography. Creep tests were interrupted and the specimens fractured at room temperature to expose any cavities or cracks formed at high temperatures for examination. After an annealing treatment of one hour at 1600°C the grain boundaries of the tungsten used in this study were populated by about 10^7 gas bubbles per square centimeter averaging approximately 0.2 μm in diameter. The bubbles were distributed nonrandomly, and there were large variations in bubble size and distribution. Different grades of tungsten showed different grain-boundary structures. Under stress at 1600°C these bubbles expanded. At low stresses they grew slowly and maintained equiaxed, crystallographic shapes. At high stresses they grew rapidly in the plane of the grain boundary and formed irregular, flat cavities about 1 μm thick. These cavities tended to grow rapidly in certain directions but always with blunt ends. No evidence of cavities nucleated by deformation was obtained, but a few rare cases of possible triple-grain junction cracks were found. Only a slight tendency for spherodization of the flat cavities was noted for annealing times as long as 100 hours at 1600°C. The model most in agreement with these observations is one in which the gas bubbles expand to form the cavities by the stress directed diffusion of vacancies along the grain boundaries. At low stresses this occurs slowly enough that the cavities are able to maintain equiaxed shapes by the process of surface diffusion. When the growth rate exceeds some critical value, surface diffusion no longer can occur rapidly enough, and the cavities grow in the plane of the boundary. Their irregular shapes suggest that the average stress does not direct their growth but that local variations in stress possibly resulting from grain-boundary sliding or deformation within the grains are responsible. The wedge-like cracks observed with the optical microscope arise when the flat cavities reach a triple-grain junction and are opened into a wedge by sliding on the adjacent grain boundaries. This model reconciles the conflicts in some of the previous models for crack formation. Since the specimen elongates as the cavities expand, their growth constitutes a creep mechanism. The creep rate from the diffusion-controlled growth of equiaxed cavities is in order-of-magnitude agreement with measured creep rates for materials containing cavities. The creep rate from growth of cavities in the concentrations present in the powder-metallurgy material used in this work is about two orders of magnitude faster than Nabarro–Herring diffusional creep would occur in the same material. Some unusual observations made on a powder-metallurgy tungsten-25% rhenium alloy which deformed at a faster rate at 1650°C than at 2200°C at a stress of 500 psi are explained semiquantitatively by this model of creep due to cavity growth and the observed microstructural features. The characteristics of creep by cavity growth are also described. (Diss. Abstr. Int., B)

9762 COOLANT AND MATERIALS FOR REACTORS: GAS-COOLED REACTORS. Jo, H. (Fuji Electric Co. Ltd., Tokyo). Genshiryoku Kogyo; 17: No. 3, 32-6(Mar 1971). (In Japanese).

Recently, pressure vessel material for gas-cooled reactors was changed from prestressed concrete to steel in order to accommodate high gas pressure in the vessels; also reactor core systems were shifted to AGR-type on the basis of the performance of Magnox reactors. The coolant for gas-cooled reactors is CO_2, whose chemical inactivity is next to He gas, however, above 625°C, CO_2 gas reacts with core graphite. In order to inhibit this reaction, CO or CH_4 gas is added into the CO_2. In AGRs, 1000 ppM CH_4–CO_2 gas is employed as the coolant. Water occurring from the CH_4–(0) reaction is removed through drying towers. Development of oxidation-resistant graphite has been achieved. For fuel cladding tubes, 20 Cr–25 Ni(20/25/Nb) is employed because it does not react with CO_2 gas at the high outlet gas temperature of 654°C. In standards for selecting steels for operational temperatures in AGRs, the service temperature is set a little lower than standards of JIS and JPI. Cobalt content in steel is limited in order to control induced-radiation. Highly radioactivated substances, neutron absorbers, and substances harmful to the reactor materials must be eliminated from the coolant. (Japan)

9763 RELATION BETWEEN THE RESULTS OF NONDESTRUCTIVE TESTS AND THE MECHANICAL PROPERTIES. Hanai, Masaru; Asaba, Yukio; Sumiya, Yukihiro (Prefectural Industrial Research Inst., Shizuoka, Japan). Shizuoka-Ken Kogyo Shikenjo Hokoku; No. 15, 173-82(Feb 1971). (In Japanese).

Results of studies on relations between radiographic data and mechanical properties are presented. It was found that the mechanical strength decreases as the defects increase. In particular, the JIS Class II defect is associated with considerable decrease of strength. The shape and distribution of defects have even greater effects on the mechanical strength. The results of model tests on shapes and distributions of defects in homogeneous material by photo-elasticity show that if two or more defects are mutually near and smaller in size, they effectively decrease the strength of metals and alloys. (auth) (Japan)

9764 DIFFUSION AND ELECTROTRANSFER OF HYDROGEN IN TANTALUM. Merisov, B. A.; Serdyuk, A. D.; Fal'ko, I. I.; Khadzhai, G. Ya.; Khotkevich, V. I. (Khar'kov State Univ.). Fiz. Metal. Metalloved.; 32: No. 3, 604-9(Sep 1971). (In Russian).

Diffusion parameters in the H–Ta system were investigated in the temperature range 0 to 150°C, and the electrotransfer velocity was measured at 20°C in small fields. The activation energy was 4,800 cal/mole and the mobility in an electric field was 10^{-3} $cm^2/V \cdot sec$. For an electric field of 3×10^{-3} V/cm an anomalous behavior was detected for the concentration distribution of H along the sample. (tr-auth)

9765 SPECIFIC HEATS OF $LaIn_3$, $CeIn_3$, AND $PrIn_3$ AT TEMPERATURES BETWEEN 1.5 AND 4.2°K. Nasu, S.; Van Diepen, A. M.; Neumann, H. H.; Craig, R. S. (Univ. of Pittsburgh). J. Phys. Chem. Solids; 32: No. 12, 2773-7(Dec 1971).

The specific heats of $LaIn_3$, $CeIn_3$, and $PrIn_3$ were measured at temperatures between 1.5 and 4.2°K. In $LaIn_3$ and $PrIn_3$ they showed the usual temperature dependence expressed in the formula $C = \gamma T + \beta T^3$, where $\gamma = 6.28 \pm 0.10$ mj $°K^{-2}$ $mole^{-1}$, $\beta = 1.06 - 0.01$ mj $°K^{-4}$ $mole^{-1}$ (Debye temperature $\theta = 194.4°K$) for $LaIn_3$ and $\gamma = 11.42 \pm 0.09$ mj $°K^{-2}$ $mole^{-1}$, $\beta = 0.94 \pm 0.01$ mj $°K^{-4}$ $mole^{-1}$ ($\theta = 202.3°K$) for $PrIn_3$. The specific heat of $CeIN_3$ was an order of magnitude higher. Because of the complex behavior of C_p/T vs. T^2 in this compound γ and β were not determined. The electron-phonon enhancement factors for $LaIn_3$ and $PrIn_3$ as determined from experiment, were found to be 0.59 and 0.54, respectively. (auth)

9766 SPECIFIC HEATS OF $LaNi_2$ AND $NdNi_2$ BETWEEN 1.6 AND 4°K. Neumann, H. H. (Univ. of Pittsburgh). J. Phys. Chem. Solids; 32: No. 12, 2788-90(Dec 1971).

The experimental results of the heat capacities of $LaNi_2$ and $NdNi_2$ are plotted in the C/T against T^2 format. The $LaNi_2$ data follow the equation $Cp = \gamma T + \beta T^3$ ($\gamma = 12.52 \pm 0.03$ mj K^{-2} $mole^{-1}$ and the Debye temperature $\theta = 0.413 \pm 0.003$ mj K^{-4} $mole^{-1}$), but the $NdNi_2$ data although showing a straight line yielding a value of $Cp/T = (101.1 \pm 0.2) + (10.8 \pm 0.02)T^2$ indicate that the specific heat cannot be associated with electronic and lattice contributions only. This conclusion is discussed. (UK)

9767 SPECIFIC HEATS OF $LaNi_5$, $CeNi_5$, $PrNi_5$, $NdNi_5$, AND $GdNi_5$ BETWEEN 1.6 AND 4°K. Nasu, S.; Neumann, H. H.; Marzouk, N.; Craig, R. S.; Wallace, W. E. (Univ. of Pittsburgh). J. Phys. Chem. Solids; 32: No. 12, 2779-83(Dec 1971).

The specific heats of $LaNi_5$, $CeNi_5$, $PrNi_5$, $NdNi_5$ and $GdNi_5$ were measured at temperatures between 1.6 and 4°K. The specific heats of $LaNi_5$, $CeNi_5$, and $PrNi_5$ can be represented by the expression $Cp = \gamma T + \beta T^3$, where $\gamma = 34.33 \pm 0.13$ mj $°K^{-2}$ $mole^{-1}$ for $LaNi_5$, 40.01 ± 0.11 mj $°K^{-2}$ $mole^{-1}$ for $CeNi_5$ and 37.02 ± 0.16 mj $°K^{-2}$ $mole^{-1}$ for $PrNi_5$; and $\beta = 0.294 \pm 0.014$ mj $°K^{-4}$ $mole^{-1}$ ($\theta = 340.9°K$) for $LaNi_5$, 0.279 ± 0.012 mj $°K^{-4}$ $mole^{-1}$ ($\theta = 347.1°K$) for $CeNi_5$ and 0.309 ± 0.017 mj $°K^{-4}$ $mole^{-1}$ ($\theta = 333.5°K$) for $PrNi_5$. The γ and β for $NdNi_5$ and $GdNi_5$ were not determined because of the complex behavior of C_p/T vs. T^2 relations due to anomalies and large magnetic contributions. (auth)

9768 SUPERPLASTICITY IN THE CADMIUM-LEAD SYSTEM. Donaldson, Kenneth Cromwell. Vancouver, British Columbia; Univ. of British Columbia (1971). National Library of Canada, Ottawa.

Thesis.

Several appropriately treated alloys (Pb–6.5 vol. % Cd, Pb–28 vol. % Cd, Cd–6 vol. % Pb and Zn–1 wt. % Al) were investigated for their superplastic properties, and documented in terms of three-stage strain rate sensitivity curves in which stage II, the region of maximum superplasticity, was of prime interest. The

investigation included analysis of: creep and tensile test data, surface deformation markings, activation energy tests, and Instron inferences of a "backstress." The rate controlling and prime strain-producing process in stage II was identified to be diffusional grain boundary sliding with slip accommodation at triple lines. Several interpretations were feasible for stage I, all involving processes concurrent with, and dependent on, grain boundary sliding. Stage III was identified as "normal" coarse-grained creep (adapted to permit considerable recovery in the vicinity of grain boundaries), operating independently of superplastic processes, and dominating at high flow stresses and strain rates. (Diss. Abstr. Int., B)

9769 NOTE ON GHOST BOUNDARIES AND SOME OF THEIR EFFECTS ON BOUNDARY MIGRATION IN INDIUM. Dasarathy, Cuppam (British Steel Corp., Port Talbot, Eng.). Prakt. Metallog.; 8: No. 10, 615-17(Oct 1971). (In German and English).

Results of examinations of segregation-type diffuse subboundaries in high-purity indium melted in a refractory crucible under argon are discussed. Results show that these diffuse subboundaries are a part of solidification sub-structures. Other interpretations of the phenomenon are discussed along with the effects of these boundaries on grain structure. (J.R.D.)

9770 EFFECT OF HEATING RATE ON THE KINETICS OF ACTIVATED SINTERING OF TUNGSTEN AND ITS PROPERTIES. Vydrevich, L. A. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 7, 578-82(Jul 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 7, 86-92(Jul 1971).

Heating rate is one of the most important technological parameters affecting process kinetics in the nickel-activated sintering of tungsten. By regulating heating rate, it is possible to vary shrinkage rate within a wide range. Mechanical tests established that the quality of sintered parts depends to a large extent on shrinkage conditions and may be improved by lowering the maximum rate of sintering to an optimum value; such a measure results in a more uniform pore distribution in sintered material, fuller reduction of oxides in tungsten powder, and higher mechanical properties. (auth)

9771 SPECIFIC HEAT MEASUREMENTS IN THE CADMIUM–ANTIMONY SYSTEM BY CONSTANT TEMPERATURE GRADIENT CALORIMETRY. Schick, George. New York; New York Univ. (1971). 142p. University Microfilms Order No. 71-29,691.

Thesis.

A constant-temperature gradient calorimeter was designed and constructed. The sensitivity of this calorimeter to pick up λ-shaped specific heat vs temperature curves was checked with liquid sulfur. Specific heat of liquid and solid alloys in the Cd–Sb binary alloy system was measured and it was found that the C_p vs T curves have negative slopes. In the 35 to 70 at. % Cd composition range, the initially large negative temperature coefficients of C_p became much smaller within a narrow temperature range and the C_p data can be described by two intersecting straight lines. The results were interpreted as supporting evidence for the existence of Cd_4Sb_3 clusters in the liquid state as evidenced by previous investigators. During the course of investigation, the metastable and stable liquidus lines of the Cd–Sb phase diagram were plotted and found to agree well with the published data. The heat of fusion of the CdSb intermetallic compound was found to be 3712 cal/g atom. The standard entropy and the standard entropy of formation were calculated and found to be 11.12 eu and –0.53 eu, respectively. (Diss. Abstr. Int., B)

9772 BEND DUCTILITY OF COLUMBIUM ALLOYS WC3015 AND Cb752. Tavassoli, A. A. (Marshall Space Flight Center, Huntsville, Ala.). Weld. J. (N. Y.); 50: No. 10, 451s-3s(Oct 1971).

Bend angles for niobium-base alloys, WC3015 and Cb752, at temperatures between –300 and +500°F are reported. WC3015 exhibited a bend transition temperature well below –100°F, but was severely embrittled by silicide coatings. Cb752 exhibited a bend transition temperature below –300°F, and the silicide coating application did not influence bend angle of the substrate. However, coating failure on both alloys was observed at less than 60° bend, even at 500°F. The effect of electron beam welding and gas tungsten-arc welding on the properties of WC3015 and Cb752 is also reported. Both techniques are shown to produce a marked reduction in the bend angle of WC3015. Unlike WC3015, ductility is restored in Cb752 after a suitable postweld anneal. Microstructural and hardness tests results for both alloys are reported and discussed. (auth)

9773 EFFECT OF BORON ADDITIONS TO AUSTENITIC STAINLESS STEELS. PART II. SOLUBILITY OF BORON IN 18 PERCENT Cr, 15 PERCENT Ni AUSTENITIC STEEL. Goldschmidt, H. J. (BSA Research Centre, Birmingham, Eng.). J. Iron Steel Inst. (London); 209: No. 11, 910-12(Nov 1971).

The solubility curve of boron in 18% Cr, 15% Ni austenitic steel is derived using optical and electron-microscopy data. The maximum solubility is found to be 0.05 at. % at the eutectic temperature of about 1125°C. The solubility boundary recedes rapidly with temperature, becoming <0.015 at. % at 900°C. The second phases are structurally similar to those reported previously in 20% Cr, 25% Ni steel. Boride analysis indicates a formula of about $M_{2.36}B$. (auth)

9774 CREEP OF FINE WIRES OF POWDER METALLURGICAL TUNGSTEN. Moon, D. M.; Stickler, R. (Westinghouse Research and Development Center, Pittsburgh). Phil. Mag.; 24: No. 191, 1087-94(Nov 1971).

The creep behavior of fine wires of pure powder metallurgical tungsten was studied over the temperature range 2100 to 3100°C. It was found that the steady-state creep rate is given by $\dot{\epsilon} = 1.81(\sigma)^{1.99}\exp[-(65{,}700/RT)]$. This result differs substantially from other reported work performed on specimens of larger diameter of polycrystalline pure tungsten. The difference is due to the fact that in the fine wire specimens numerous grain boundaries traverse the entire diameter. Creep can therefore take place by grain boundary sliding in these samples without the necessity of extensive grain deformation as is required for larger specimens where the grain size is much smaller than the sample diameter. (auth)

9775 PROPERTIES OF A FABRICABLE, HIGH STRENGTH SUPERALLOY. Eiselstein, H. L. Metals Eng. Quart.; 11: No. 4, 20-5(Nov 1971).

Results of the process development for production of fabricable Inconel 706 having optimized properties are reported. (J.R.D.)

9776 DENSITY OF THE LIQUID ALLOYS IN THE BISMUTH–INDIUM SYSTEM. Petrescu, N. (Center of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 16: No. 8, 1171-7(Aug 1971).

The variation of density with composition has been determined in the molten Bi–In alloys in the concentration range 40 to 60 at. % Bi for the temperature interval 112 to 220°C, by a dilatometric method. The excess volume is positive for all the investigated liquid alloys, showing a minimum at the equiatomic composition, which corresponds to the solid InBi compound. This peculiarity is manifest on the density isotherms by deviations from a smooth composition dependence; the deviations are more pronounced closely to the melting point and tend to vanish at 220°C. (auth)

9777 COMMENTS ON STRESS INDUCED DIFFUSION OF OXYGEN IN ALPHA ZIRCONIUM. Mishra, S.; Asundi, M. K. (Bhabha Atomic Research Centre, Bombay). Scr. Met.; 5: No. 11, 973-6(Nov 1971).

The occurrence of an internal friction peak in Zr at a temperature of about 441°C at 0.75 Hz was previously reported by Browne (Scripta Met. 5, 519(1971)). The peak was interpreted as due to either oxygen–hafnium pair mechanism or oxygen–oxygen pair mechanism. Reasons are given for the belief that the peak is more likely due to oxygen–titanium interactions. (P.C.H.)

9778 REPLY TO COMMENTS ON STRESS INDUCED DIFFUSION OF OXYGEN IN ALPHA ZIRCONIUM. Browne, K. M. (Central Research Lab., Newcastle, Australia). Scr. Met.; 5: No. 11, 977-9(Nov 1971).

A rebuttal is given to the preceding paper in which it is believed that the internal friction peak previously reported (Brown, K. M., Scripta Met., 5, 519(1971)) in Zr–O alloys containing 2.4% Hf, 0.1% Fe, and 0.1% Ti as substitutional impurities, is due to a Ti–O pair relaxation rather than either Hf–O or O–O pair relaxation, which was originally suggested. It is stated that the internal friction peak originally reported in Zr–O alloys containing 2.4% Hf is attributed to Hf–O or O–O relaxation as before since the high temperature peak ascribed by the preceding paper to Hf–O relaxation should be interpreted as a grain boundary peak. Also the preceding paper does not refute the possibility of an O–O relaxation but instead provides further evidence for its existence. (P.C.H.)

9779 STUDY OF THE EFFECTS OF INTERSTITIALS ON THE EMBRITTLEMENT OF TITANIUM AND ZIRCONIUM UNDER THE APPLICATION OF STATIC AND DYNAMIC LOADS. Puttlitz, Karl Joseph. East Lansing, Mich.; Michigan State Univ. (1971). 326p. University Microfilms Order No. 71-31,292.

Thesis.

The traditional studies of the effects of interstitials on the mechanical properties of both titanium and zirconium involved

the preparation of the alloys by making additions of these impurities to the melt. Small quantities of oxygen and nitrogen were found to drastically strengthen these metals and embrittle them at very modest levels. Although these facts are well documented, it is the purpose of this study to define the conditions that these materials will still possess good fracture toughness after elevated temperature treatment in the atmospheres of these gases. Evidence is presented to show that both metals failed in a state of plane stress for all treatments of the test schedule for a 0.4 inch section plate. Additional evidence indicates that some losses in dynamic fracture toughness are due to changes in the phase morphology. Hydrogenated pure and commercially pure titanium, and reactor-grade zirconium are shown to fail under impulsive loading conditions. Fracture models constructed from the phase and fracture morphology are presented. (Diss. Abstr. Int., B)

9780 EFFECT OF SUBSTRATE TEMPERATURE AND REACTANT GAS PRESSURE ON THE MECHANICAL BEHAVIOR OF CVD TUNGSTEN. Shim, Hong Seop. Salt Lake City, Utah; Univ. of Utah (1971). 97p. University Microfilms Order No. 72-528.

Thesis.

Experimental work was carried out to determine the effect of substrate temperature and the gas pressure on the mechanical behavior of CVD tungsten. The crystal morphology, yield strength, hardness, fluorine content, preferred orientations and dislocation density were found to be strongly affected by substrate temperature, but very little by total pressure of the reactant gases. Lower substrate temperatures resulted in vastly stronger and harder deposits according to hoop stress test and microhardness measurement. Possible causes for the observed strength difference between deposits are discussed in regard to facts that lower substrate temperature deposits have less fluorine content, dislocation density, ⟨100⟩ fiber axis, and have more disturbed structure; i.e., fanning out of columnar grains. Scanning electron microscopy revealed that the individual tungsten crystals advance with four sided pyramids at the interface. Also fracture modes and surfaces were observed and discussed. An apparent activation energy for the growth of CVD tungsten was found to be approximately 16 kcal/mole. (Diss. Abstr. Int., B)

9781 STRENGTHENING MECHANISMS IN γ' HARDENED NICKEL BASE ALLOYS. Singhal, L. K. (Indian Inst. of Tech., Kanpur). Scr. Met.; 5: No. 11, 959-64(Nov 1971).

Studies on strengthening mechanisms showed that a major part of the strengthening effect in alloys containing Ni_3AlTi precipitates arises on account of the antiphase boundary energy of the precipitates. Thus in alloys containing γ' precipitates it is not realistic to assume that the strength of the alloys will be necessarily higher if the particle-matrix misfit increases. (P.C.H.)

9782 EMPIRICAL POWER LAW AND THE ACTIVATION PARAMETERS OF HIGH TEMPERATURE FLOW. Jonas, J. J.; Luton, M. J. (McGill Univ., Montreal). Scr. Met.; 5: No. 11, 935-41(Nov 1971).

The experimental activation energy Q′ is defined by: $Q' = -k\,(\partial \ln \dot{\epsilon})/\partial(1/T)_\sigma$ and is frequently given fundamental significance by comparison with the activation energy for self diffusion, or for some other basic process. Because of the widespread nature of this practice, the power law was considered from the point of view of activation analysis and the physical significance of the terms C, n, and Q′ are defined more rigorously. To simplify the analysis, only the yield condition is considered. In this way the problems associated with the presence of internal stresses, and with the dependence of their magnitudes on the recovery rates, can be eliminated. The calculations are based on the behavior of α-zirconium. It was concluded that power law fits are extremely convenient for the first level analysis of experimental data, but that the rate equation parameters obtained from such fits should be converted to their conventional equivalents in the manner indicated if they are to be given a physical interpretation. (P.C.H.)

9783 STRESSES IN THORIA-DISPERSED NICKEL AFTER RAPID QUENCHING-EFFECTS ON THE FLOW STRESS AT ROOM TEMPERATURE. Lasalmonie, A. (Centre des Materiaux de l'Ecole Des Mines, Corbeil, France). Scr. Met.; 5: No. 11, 1013-16(Nov 1971).

Studies were made to determine if the stresses in thoria-dispersed Ni after rapid quenching are plastically relaxed and if they affect the mechanical properties of the alloy at room temperature. It was concluded that: the quenching-stresses are not relaxed; though being important, they do not significantly increase the flow stress, and the hardening effect vanishes after 1% deformation. It seems likely that the secondary slip around particles quickly relaxes the quenching stresses. (P.C.H.)

9784 COADSORPTION OF NITRIC OXIDE, NITROGEN, AND OXYGEN ON RHENIUM. Tamura, Teijiro (Kyoto Technical Univ.). Bull. Chem. Soc. Jap.; 44: No. 8, 2116-19(Aug 1971).

The coadsorption of nitric oxide, nitrogen, and oxygen on a polycrystalline rhenium filament was studied using flash desorption mass-spectroscopy. Substitutional desorption was not observed during the adsorption of nitric oxide, nitrogen, or oxygen on preadsorbed layers. No oxygen or nitrogen adsorbs on rhenium saturated with nitric oxide. However, nitric oxide adsorbs on rhenium saturated with nitrogen or oxygen. The strength of the chemisorption bond between rhenium and adsorbed species becomes weaker in the order of: nitric oxide, oxygen, and nitrogen. When the same amount of nitric oxide molecules exist in various coadsorbed layers, the Tp of the nitrogen desorption spectrum from these layers is shifted to a lower temperature with an increase in the number of oxygen atoms in them, because the strength of the chemisorption bond of Re−N is weakened by the strongly-bonded Re−O. No desorption of the nitric oxide molecule from a coadsorbed layer of the "$N_2 + O_2$" on rhenium was observed. (auth)

9785 TEMPERATURE DEPENDENCE OF SOLID SURFACE ENERGY. Gladkikh, M. T.; Khotkevich, V. I. Dopov. Akad. Nauk Ukr. RSR, Ser. A; 344-8(1971). (In Belorussian).

A method is proposed for determining temperature dependence of a temperature coefficient of solid surface energy. The method is based on an experimental measurement of melting temperature of dispersed particles or thin films in relation to their dimensions. Temperature dependence is obtained for solid indium surface energy, temperature dependence of surface energy temperature coefficient is found for indium and nitrogen, and vacancy formation energy was determined for tin and indium. (auth)

9786 EFFECT OF BORON ADDITIONS TO AUSTENITIC STAINLESS STEELS. PART I. EFFECT OF BORON ADDITIONS TO 20 PERCENT Cr, 25 PERCENT Ni AUSTENITIC STEEL WITH AND WITHOUT Nb, Mn, AND Si. Goldschmidt, H. J. (BSA Group Research Centre, Birmingham, Eng.). J. Iron Steel Inst. (London); 209: No. 11, 900-9(Nov 1971).

The solid solubility of boron is determined in austenitic stainless steel of base 20% Cr, 25% Ni, and 20 Cr, 25 Ni^+ (Nb, Mn, Si, 0.6% each) at various temperatures. The maximum solubility in 20 Cr, 25 Ni steel is found to be 0.03 at. % at the eutectic temperature of 1150°C. In 20 Cr, 25 Ni steel with Nb, Mn and Si the maximum solubility is 0.08 at. % at the eutectic temperature of 1225°C. The rates of recession of the solution boundaries with temperature are high, while considerably different between the two steels. Boron tends to grain-boundary segregation and, when in γ solution, to interstitial or substitutional lattice sites. The first borides equilibrating are determined. In 20 Cr, 25 Ni steel the compounds liable to form are the $M_{23}C_6$ type carbo-boride and M_2B type borides. The Nb, Mn, and Si additions cause a significant difference by giving rise to intermetallic formation. (auth)

9787 SUBSTRUCTURE STRENGTHENING IN ZIRCONIUM AND ZIRCONIUM–TIN ALLOYS. Abson, D. J.; Jonas, J. J. (McGill Univ., Montreal). J. Nucl. Mater.; 42: No. 1, 73-85 (Jan 1972).

The substructures developed during the hot compression of α-Zr and a series of Zr−Sn solid solution alloys were examined by means of transmission electron microscopy. The materials were hot compressed in a modified Instron testing machine at constant true strain rates of 10^{-4} to 3×10^{-1} sec^{-1}. The range of testing temperatures was 625 to 825°C. Over the subgrain size range 0.3 to 7 μm, the high temperature flow stress and subgrain size were inversely related. The increase in flow stress due to substructure formation also obeyed this type of relation. The results are consistent with a glide model of deformation in which the buildup of internal stress is due to the substructure developed by the deformation. Room temperature yield strengths were measured on cylinders machined from the hot compressed samples. The data obeyed an equation of the modified Hall−Petch type in which the strength increased linearly with the inverse subgrain size. This relationship reflects the change in sub-boundary strength resulting from a reduction in the perfection of the sub-boundaries and an increase in their redundant dislocation content as the subgrain size decreased. (auth)

9788 DIFFUSION OF NICKEL AND TIN IN ZIRCALOY-2. Pande, B. M.; Agarwala, R. P. (Bhabha Atomic Research Centre, Trombay, India). J. Nucl. Mater.; 42: No. 1, 43-8 (Jan 1972).

The diffusion of nickel and tin in alpha and beta Zircaloy-2 has been studied by the residual activity technique in the temperature

range 650 to 1250°C. The temperature dependence of diffusivities (cm^2/sec) can be expressed as

$$D_{Sn/\alpha\text{-Zircaloy-2}}\ (650-780°C) = (3.31 \pm 0.56) \times 10^{-6} \exp \frac{-36,630 \pm 377}{RT},$$

$$D_{Sn/\beta\text{-Zircaloy-2}}\ (980-1250°C) = (2.80 \pm 0.56) \times 10^{-1} \exp \frac{-55,905 \pm 809}{RT},$$

$$D_{Ni/\alpha\text{-Zircaloy-2}}\ (650-780°C) = (1.00 \pm 0.17) \times 10^{-7} \exp \frac{-29,339 \pm 296}{RT},$$

and

$$D_{Ni/\beta\text{-Zircaloy-2}}\ (980-1250°C) = (7.30 \pm 1.16) \times 10^{-3} \exp \frac{-47,960 \pm 587}{RT}$$

The results are explained on the basis of alloying characteristics of Zircaloy-2 and it is noted that with the exception of tin, the small percentage of other constituents in Zircaloy-2 does not affect the diffusion properties. (auth)

9789 AGE HARDENING OF Zr–2.5 WT. PERCENT Nb SLOWLY COOLED FROM THE ($\alpha + \beta$) PHASE FIELD. Aldridge, S. A.; Cheadle, B. A. (Chalk River Nuclear Labs., Ont.). J. Nucl. Mater.; 42: No. 1, 32-42(Jan 1972).

Zirconium–2.5 wt % niobium, furnace cooled or air cooled from the ($\alpha + \beta$) phase field increased in hardness when aged in the temperature range 300 to 500°C. Electron micoscope studies revealed a fine two phase structure of α zirconium grains surrounded by a network of a second phase identified by x-ray diffraction to be cubic β-zirconium containing about 20 wt % Nb. When the β-zirconium phase was aged in this temperature range it transformed to enriched-β and ω phases with a corresponding increase in hardness and strength. From this it is inferred that the hardness and strength increases observed in the two phase alloy are due to the age hardening of the β phase. This composite structure of ductile α grains in a hard strong network may be the reason for the good in-reactor creep resistance of extruded and cold-worked pressure tubes. (auth)

9790 RESISTANCE OF NITRIDED MOLYBDENUM ALLOYS TO HIGH-TEMPERATURE DEFORMATION. Lakhtin, Yu. M.; Kogan, Ya. D. Izv. Akad. Nauk SSSR, Metal.; No. 5, 145-50(Sep-Oct 1971). (In Russian).

Nitriding significantly raised the heat strength of Mo alloys. The strengthening effect during surface alloying with nitrogen amounted to at least 50 to 100% at 1,000 to 1,400°C. The resistance to plastic deformation of nitrided molybdenum at high temperatures was enhanced, and is probably due to the formation of nitrides of Mo, Ti, and Zr in and on the grain boundaries. (tr-auth)

9791 ORIENTED DEFORMATION OF SHEET MOLYBDENUM. Borimskaya, S. T.; Gal'chinskii, F. K.; Igolkina, L. S.; (and others). Izv. Akad. Nauk SSSR, Metal.; No. 5, 195-202(Sep-Oct 1971). (In Russian).

Anisotropic (oriented) deformation aging of Mo was studied at elevated temperatures. Examination of the metal structure of thin Mo before and after rolling showed that an equiaxially developed cellular structure developed, which was essentially unchanged by annealing at 1,100°C. The crystallographic aspects of disintegration and the role of the texture are discussed, and a mechanism of oriented disintegration is advanced. (K.S.W.)

9792 POSSIBILITY OF DETERMINING THERMODYNAMIC ACTIVITIES IN BINARY ALLOYS FROM DATA FOR THE MUTUAL DIFFUSION AND SELF DIFFUSION OF THE COMPONENTS. Fedorov, G. B.; Smirnov, E. A.; Ugaste, Yu. E.; Gusev, V. N.; Marchukova, I. D. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 3, 392-3(Mar 1971).

Translated from Zh. Fiz. Khim.; 45: No. 3, 704-6(Mar 1971).

The possibility of determining the thermodynamic activities of the components of binary systems based on substitutional solid solutions by graphical integration of Darken's equation has been demonstrated. The calculations of the thermodynamic activities for the systems silver–gold, nickel–chromium, and zirconium–niobium are presented as examples. The authors' and the literature data for the mutual diffusion and self-diffusion of the components obtained with the aid of x-ray microanalysis and radioactive isotopes were employed in the calculations. The examples on the calculation of the errors in the determination of the activities suggests that the proposed method is quite acceptable for the determination of thermodynamic data and the estimation of their reliability. (auth)

9793 ELECTROMOTIVE FORCE STUDY OF THE STATE OF LIQUID CERIUM–BISMUTH SOLUTIONS. Kober, V. I.; Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. R. (Urals Polytechnic Inst., Sverdlovsk, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 3, 313-15(Mar 1971).

Translated from Zh. Fiz. Khim.; 45: No. 3, 569-72(Mar 1971).

The emf's between metallic cerium and its liquid solutions in bismuth were measured in fused salt electrolytes in the range 500 to 650°C. The thermodynamic quantities characterizing the state of cerium in bismuth solutions and the solubility of cerium in bismuth have been determined from the results. (auth)

Structure and Phase Studies

Refer also to abstracts 9209 and 10352.

9794 (AEC-tr-7286) MORPHOLOGICAL CHANGES OF METAL TIPS BY HEAT TREATMENT (VERIFICATION OF THE NICHOLS AND MULLINS THEORY). Vu Thien Binh; Piquet, A.; Roux, H.; Uzan, R.; Drechsler, M. Translated from Surface Sci.; 25: 348-56(1971). 8p. Dep. NTIS.

The morphological evolution of conical tungsten tips of cone angles between 1 and 15° at temperatures between 1800 and 3000°K was studied inside a scanning electron microscope. The experimental results confirm the theory of Nichols and Mullins concerning the existence of a critical cone angle $\alpha = 3°$, formation of solid drops for $\alpha < 3°$, and formation of characteristic steady-state shapes for $\alpha > 3°$. For a temperature in the order of 2900°K (clean surface) the curvature radius at the tip apex increases with time according to the $t^{\frac{1}{6}}$ law. For temperatures below 2700°K discrepancies were found, which are due to an evaporation of tungsten compounds produced at the surface by a chemical reaction with the residual gas (10^{-8} torr). The measurements at 2900°K enabled the determination of the surface diffusion coefficient of tungsten: $D = 2.4 \times 10^6$ cm^2/sec. (auth)

9795 (COO-1778-7) STUDY OF GRAIN BOUNDARY SEGREGATION USING THE AUGER ELECTRON EMISSION TECHNIQUES. Final Technical Report. Stein, D. F. (Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering). 1 Jul 1971. Contract AT(11-1)-1778. 11p. Dep. NTIS.

Activities in a program directed to the use of Auger spectroscopy to study segregation of impurities toward grain boundaries in metals are summarized. Information is included on grain boundary fracture research involving low alloy steels, boron steels, Cu–Bi alloys, and refractory metals. Results of research are also included on corrosion of steel, metallurgy of W, and metallurgy of Fe. (J.R.D.)

9796 (LBL-119) STABILITY OF A15 TYPE PHASES AS AFFECTED BY ELECTRON CONCENTRATION. Hartsough, Larry Dowd (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 111p. Dep. NTIS. Thesis.

The data for known A15 binary phases are used to develop criteria for stability and superconductivity of hypothetical A15 phases. The occurrence of A15 phases is examined in terms of the valence bond concepts of the Engel-Brewer correlation and in its frequency with changes in electronic density of states. The phase is most favored in systems containing V, Nb, or Cr, with atoms differing by no more than 8% in radii, at compositions determined by electron concentration, and at relatively low temperature. Composition, temperature of formation, and lattice parameter are predicted for a number of hypothetical A15 phases. The predicted lattice parameter and concentration are used to compare with the observed correlation between T_c and electrons per unit volume. A new A15 superconductor, V_3Al, was found by evaporation and cocondensation of the elements onto substrates held at temperatures between ~350 and 450°C. Once formed, the phase is stable to ~660°C, above which it decomposes to the V–Al bcc solid solution. The lattice parameter of the A15 phase increases slightly with Al content, from 4.829 ± 0.003 Å for the vanadium-rich composition. T_c was increased from 9.6 to ~11.1°K by annealing for 8 hours at ~600°C. (auth)

9797 (LBL-129) EFFECT OF RHENIUM ADDITIONS ON ANISOTROPIC SLIP IN SINGLE MOLYBDENUM CRYSTALS. Liu, Chih-an (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1971. 68p. Dep. NTIS.

Thesis.

The yielding behavior of bcc crystals has been reported to depend asymmetrically on crystal orientation at low temperatures. This asymmetric yielding behavior was generally assumed to be due to the dissociation of the (a/2)⟨111⟩ screw dislocations. Studies were made on the alloying effect on the asymmetric yielding behavior of bcc crystals. The Mo–Re alloy system was chosen because it was believed that adding Re to Mo would lower the stacking fault energy of Mo and increase the tendency of dissociation of the (a/2)⟨111⟩ screw dislocations, hence increase the asymmetry. Single crystals of two Mo–Re alloys, 10 at. % and 20 at. % Re, each in three different orientations, were tested under tension at low temperatures. The yield stress and slip band formation of these crystals were found to depend on test temperature, solution concentration, and, below room temperature, asymmetrically on crystal orientation. The asymmetric yielding behavior was found to be in reasonably good agreement with the pseudo-Peierls mechanism proposed by Dorn and Mukherjee as in the case of pure Mo reported by Lau and Dorn. However, the degree of asymmetry in the Mo–Re alloys was found to be less than that for Mo in contrast to the original expectation. The asymmetric behavior decreased with increasing temperature and vanished above room temperature. A possible mechanism to explain this behavior is discussed. The solid solution hardening rate for slip on the {110} planes was found to be higher than that on the {112} planes. The cleavage plane changed from {001} planes for Mo and Mo–10 at. % Re alloy {112} planes for the Mo–20 at. % Re alloy. Unlike quasi-parabolic or three-stage hardening stress-strain relation reported for other bcc metals, the deformation of Mo–Re alloys was rather inhomogeneous with a relatively low strain hardening rate. This might be due to the simple and confined slip system observed. (auth)

9798 (ORO-3262-23) INVESTIGATION OF ANOMALOUS WORK HARDENING AND DYNAMIC RECOVERY IN TITANIUM AND ZIRCONIUM. Progress Report. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). 15 Aug 1971. Contract AT(40-1)-3262. 33p. Dep. NTIS.

Research is reported on tests of Ti involving relations associated with the Cottrell–Stokes law, the effects of purity on strain rate sensitivity of Ti, effects of twinning on stress-strain curves for Zr, serrated yielding of Ti, theory of relaxation in Zr and Ti, effects of twinning on deformation in Zr, ductility of Zr, damping capacity of Zr, load carrying capacity of hexagonal metals, slip modes in Zr, interactions of twinning and slip in Zr, strain anisotropy in Ti, strain rate changes on stress-strain curves for Ti, tensile properties of Zr, and polycrystalline deformation study techniques. (J.R.D.)

9799 SURFACE STATE OF TITANIUM–TUNGSTEN ALLOYS. Novikova, M. B.; Kagan, A. S.; Tret'yakov, V. I. Tsvetn. Metal.; No. 8, 61-3(Aug 1971). (In Russian).

The phase composition of the surface of metalloceramic Ti–W solid alloys was studied with x-ray diffraction techniques. The x-ray index could be used to ascertain whether the surface of a given sample was depleted or enriched in Ti phase or if the surface was wholly (Ti,W)C. It was established that two qualitatively different types of surfaces of fired metalloceramic Ti–W products exist: a layer with the phase (Ti,W)C, and a layer with the phase WC and Co. (K.S.W.)

9800 PRECIPITATION AND RECRYSTALLIZATION BEHAVIOUR OF THE NICKEL-BASE-ALLOY INCONEL 625. Schnabel, Ekkehard; Schueller, Hans-Juergen; Schwaab, Paul (Mannesmann AG, Duisburg, Ger.). Prakt. Metallog.; 8: No. 9, 521-7(Sep 1971). (In German and English).

The precipitation behavior of the Ni-base alloy Inconel 625 was investigated using optical and electron microscopes over the temperature range 600 to 1100°C for times between 5 min and 300 hr and represented in a time-temperature-precipitation diagram. The recrystallization behavior was also determined at temperatures between 800 and 1250°C and deformations up to 35%. The carbides $M_{23}C_6$ and M_6C and the carbonitrides MX and M_2X were detected using electron diffraction. Furthermore, the intermetallic phases γ^+-$NbNi_3$, (Mo,Nb)Ni_3, and η-Ni_3Ti were found. Of these phases $M_{23}C_6$ and γ^+-$NbNi_3$ were not stable. (auth)

9801 SUMMARY OF BINARY PHASE DIAGRAMS. WALL CHART. Contract AT(33-1)-GEN-53. Document Number Y3.AT:26B51. Miamisburg, Ohio; Monsanto Research Corporation (1971). 1p. GPO $0.30.

A chart that describes the binary phase diagrams existing between two elements is presented. The chart summarizes some of the more important details of the phase diagrams. Fifty-five alphabetically arranged elements are considered. (R.C.K.)

9802 AGING OF ULTRATHIN FILMS MADE BY CONDENSATION OF TANTALUM AND IRIDIUM VAPORS IN VACUUM. Kholmyanskii, V. A. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 625-8(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 721-5(May 1971).

Irreversible changes in the electrical resistance during aging of ultrathin films deposited by condensation of tantalum and iridium vapor in vacuum were investigated. It was established that the electrical resistance of all the thin films obeys an exponential time dependence (except for a brief initial period). An explanation of the laws of aging is offered in which two diffusion processes with opposite effects are the predominant control factors. (auth)

9803 CRYSTAL STRUCTURES AND LATTICE PARAMETERS OF BERKELIUM METAL. Peterson, J. R. (Univ. of Tennessee, Knoxville); Fahey, J. A.; Baybarz, R. D. J. Inorg. Nucl. Chem.; 33: No. 10, 3345-51(Oct 1971).

The first bulk samples of berkelium metal were prepared by the reduction at ~1000°C of BkF_3 with lithium metal in a tantalum crucible system. Berkelium metal was found to exhibit two stable crystallographic modifications—face centered cubic (fcc) and double hexagonal closest packed (dhcp). The cubic lattice parameter, derived from the averaged values of 10 independent metal samples, is 4.997 ± 0.004 Å. The dhcp lattice parameters, derived from the averaged values of 6 independent samples, are a_0 = 3.416 ± 0.003 Å and c_0 = 11.069 ± 0.007 Å. The error limits given in all three cases represent the 95% confidence level calculated using the standard statistical method for the average of independent determinations. (auth)

9804 PHASE DIAGRAMS OF THE SYSTEM Nb_3Al–Nb_3Ga–Nb_3Ge. Ageev, N. V.; Alekseevskii, N. E.; Shamrai, V. F. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 198: No. 3, 611-13(21 May 1971). (In Russian).

A study was made of the critical temperature, lattice parameters, and microhardness of certain sections of the pseudoternary system Nb_3Al–Nb_3Ge–Nb_3Ga. Attention was also given to the binary systems Nb_3Ga–Nb_3Ge; Nb_3Al–Nb_3Ga; and $Nb_{12}Al_3Ga$–$Nb_{12}Al_3Ge$. Most samples were annealed at either 700 or 1,200°C. During alloying of Nb_3Al with gallium, it was found that small additions of Ga produced small rises in the critical temperature. The alloy consisting of 75 at. % Nb, 18 at. % Al, 7 at. % Ga had a critical temperature of 18.95°K. The compound Nb_3Al had a $T_{crit.}$ = 18.66°K. (K.S.W.)

9805 MICROSTRUCTURES AND MECHANICAL PROPERTIES OF IRON-BASE (-CONTAINING) SUPERALLOYS. Sullivan, C. P.; Donachie, M. J. Jr. (United Aircraft Corp., East Hartford, Conn.). Metals Eng. Quart.; 11: No. 4, 1-11(Nov 1971).

The microstructures and properties of these alloys are reviewed. Information is included on physical metallurgy, alloy types, strengthening, overaging, intermetallic phases, carbides, effects of boron, and alloy processing. (J.R.D.)

9806 INVESTIGATION OF PHASE TRANSFORMATIONS IN NICKEL RICH, Ni–V, Ni–V–Nb AND Ni–V–Ta ALLOYS. Moreen, Harry Allen. Seattle, Wash.; Univ. of Washington (1971). 283p. University Microfilms Order No. 71-28,450.

Thesis.

A study of the precipitation processes in the Ni–V and Ni–V–Nb systems has been undertaken with the object of examining the factors determining the occurrence and the relative stability of a variety of ordered phases in nickel alloy systems and to examine the microstructural mechanisms of the precipitation reactions which occur during the formation of the ordered phases. Ordered phases with compositions of Ni_8V, Ni_8(V,Nb) and Ni_8(V,Ta) have been identified and shown to possess the structure of Ni_8Nb and Ni_8Ta. The critical temperature of order–disorder for the Ni_8V phase has been shown to be 405°C. The critical temperature of the ternary Ni_8(V,Ta) and Ni_8(V,Nb) alloys shows a linear dependence on the concentration of Ta or Nb in agreement with calculations based upon the Bragg–Williams analysis. An ordered phase, identified as Ni_3V with the DO_{22} structure, has been observed to form in binary Ni–V alloys with V content ranging from 16 V to 19 at. % V. The precipitation reaction producing Ni_3V has been shown to be a two stage process. The sequence of precipitation is $FCC \rightarrow FCC_{V\,rich} + FCC_{V\,lean} \rightarrow FCC + Ni_3V$. The first stage of the decomposition of the supersaturated solid solution proceeds by a spinodal decomposition process which results in a tweed microstructure consisting of V-rich and V-lean composition modulations lying along matrix ⟨10⟩. The spinodal decomposition reaction leads to the formation of internal strains which result in lattice parameter changes, x-ray line broadening and electrical resistivity increases. The second stage of the decomposition reaction involves the formation of the ordered Ni_3V phase in the V-rich regions of

the spinodally decomposed alloys which exhibits classical C-curve transformation behavior. All of the individual Ni_3V particles that form in a localized region of a given matrix grain are of the same variant of the DO_{22} structure as a result of the interaction of the internal strains created by the spinodal decomposition with the nuclei of the Ni_3V phase. The growth of Ni_3V follows a $t^{\frac{1}{3}}$ law in agreement with the general ripening kinetics reported on other systems. The activation energy of 65 kcal/mol compares favorably with the activation energy for diffusion of V in Ni, 66.5 kcal/mol, and indicates that diffusion is the rate controlling mechanism. The substitution of Nb for V in Ni–Nb–V alloys suppresses the spinodal decomposition reaction and favors the so called homogeneous nucleation of the $Ni_3(V,Nb)$ phase. The homogeneously nucleated precipitate also possesses the DO_{22} structure but forms as discs which lie parallel to matrix {100} with the tetragonal DO_{22} c axis normal to the plane of the disc. The suppression of the spinodal reaction is attributed to the increase in strain energy associated with the larger Nb atoms. Mechanical property tests show that the strength of the alloys is controlled by the internal strain according to the Mott and Nabarro theory of hardening and that the ductility of the alloys is reduced as superdislocations are forced to cut the Ni_3V precipitates. A new type of superdislocation consisting of four matrix a/2 ⟨110⟩ dislocations has been observed associated with the Ni_3V DO_{22} structure. (Diss. Abstr. Int., B)

9807 PRE-MARTENSITIC TRANSFORMATION IN Au–Cd AND Fe–Ni ALLOYS. Livingston, Hyman Leon. Brooklyn; Polytechnic Inst. of Brooklyn (1971). 93p. University Microfilms Order No. 71-29,073.

Thesis.

Pre-martensitic transformation characteristics have been investigated in the Au–47.5 at. % Cd and Fe–29.7 at. % Ni alloys by various techniques. The electronic measurements include electrical resistivity, transverse magnetoresistance, and Hall effect. X-ray curve-broadening and internal friction measurements on the Au–Cd alloy above the martensitic transformation temperature (Ms) were also carried out. Preliminary electron diffraction on the Au–Cd alloy has also been performed. These measurements were carried out on slow cooling the alloys above their respective Ms temperatures. An anomalous magnetoresistance peak was observed for both of these alloys prior to the martensitic transformation. In the Au–Cd alloy this peak was about two to three degrees centigrade above the Ms and that for the Fe–Ni alloy was about five to six degrees above the Ms. Furthermore, when the Ms was lowered by isothermal stabilization, this peak moved in conjunction with the new Ms temperature. This indicates that the observed peak is truly associated with the pre-martensitic instability of the high temperature phase. The Hall constant, R_H, was measured in the Au–Cd system from 100°C to immediately above the Ms, and linearly decreased with decreasing temperature. This suggests that the electronic changes might be related to the martensitic transformation. The electron diffraction pattern of the high temperature phase of Au–Cd showed extensive streaking in the same range of temperatures as the anomalous magnetoresistance behavior. The indirect and direct measurements have been interpreted in terms of anisotropic scattering centers resulting from strain inhomogeneities. It is presumed that these inhomogeneities are associated with atomic shuffling preceding the actual martensitic transformation and might be identified as the so-called strain embryos. (Diss. Abstr. Int., B)

9808 ROLE OF Cr AND Zr ON THE ROLLING AND ANNEALING TEXTURE IN Cu–Cr, Cu–Zr, AND Cu–Zr–Cr ALLOYS. Nagai, Takeshi; Henmi, Zenzo; Hirai, Iesada (Fujitsu Labs., Ltd., Kawasaki, Japan). J. Jap. Inst. Metals; 35: No. 10, 965-9(Oct 1971). (In Japanese).

In a previous paper, the retardation of recrystallization in Cu–Cr, Cu–Zr, and Cu–Zr–Cr alloys could not be fully accounted for by either fine precipitates or solute atoms. Studies were made on the rolling and annealing textures in these alloys. The rolling textures of Cu–Cr alloy are described by (110) $[1\bar{1}2]$ + (112) $[1\bar{1}1]$ (Cu-type). Cu–Zr and Cu–Zr–Cr alloys have the same textures described by (110) $[1\bar{1}2]$ (brass-type). But the annealing textures of Cu–Cr alloy are described by (225) $[73\bar{4}]$ + (100) [001]. Cu–Zr and Cu–Zr–Cr alloys have the same annealing textures described by (110) [112] (recrystallization in situ). If Cr and Zr remain to be solved during recovery and recrystallization, the annealing textures must become the Cu-type (100) [001] or the brass-type (225) $[73\bar{4}]$. The reason for such a difference between the annealing textures of these alloys was considered due to the formation of fine precipitates during recrystallization which obstructs dislocation climb sliding, and grain boundary migration. (auth)

9809 DETERMINATION OF THE FERROMAGNETIC COBALT PHASE IN SINTERED HARD ALLOYS BY MEASURING THE FORCE REQUIRED TO DETACH A PERMANENT MAGNET. Gavrilyuk, M. M.; Davydovich, A. V. Defektoskopiya; No. 5, 131-2(1970). (In Russian).

A method of measuring the amount of Co present in hard alloys of the WC–Co and TiC–Co types by determining the force required to detach a standard permanent magnet from the surface is described. In accuracy this method is in no way inferior to metallographic techniques and other magnetic methods based on coercive force and saturation magnetization. It is simple and convenient, and the error rarely exceeds 5%. (Metals Abstr.)

9810 FORMATION OF FAN-SHAPED PRECIPITATES DURING THE DECOMPOSITION OF A HIGHLY SUPERSATURATED Al–Zr SOLID SOLUTION. Nes, E. (Central Inst. for Industrial Research, Oslo); Ryum, N. Scr. Met.; 5: No. 11, 987-9(Nov 1971).

Comments are given on the interpretations by others on the decomposition of a highly supersaturated Al–Zr solid solution. It was concluded that the fan-shaped precipitates are associated with grain boundary migration, and the discontinuous precipitation mechanism appears to be the most likely explanation. In a supersaturated solid solution of a slowly diffusing species like Zr, a moving grain boundary will serve as an extremely efficient agent in reducing the Zr concentration by a discontinuous precipitation process. (P.C.H.)

9811 TWINNING IN CUBIC SUPERLATTICES. Arunachalam, V. S.; Sargent, C. M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Scr. Met.; 5: No. 11, 949-53(Nov 1971).

The possibility of deformation twinning occurring in cubic superlattices based on the definition of twinning adopted by Bilby and Crocker (Proc. Roy. Soc. A 288, 240(1965)) was re-examined. Reference to a superlattice is defined as the structure derived from a bcc (or fcc) phase by ordering of the constituent species. Consideration was given to only those twinning modes that fully restore the ordered lattice, i.e., any shuffling of the atoms after twinning was not allowed. The results showed that twinning is possible in two of the three cubic superlattices examined; namely, in the $L2_0$ superlattice (CuZn) and $Ll_2(Ni_3Al)$ but not in $DO_3(Fe_3Be)$. The cubic superlattices that do twin, do not exhibit the same modes as those of the disordered lattices from which they were formed. The superlattices do, in fact, represent new crystal structures which must obey separate criteria. (P.C.H.)

9812 PRIMARY SOLID SOLUTIONS IN BINARY NICKEL ALLOY SYSTEMS. Stefec, R. (Inst. of Chemical Tech., Prague). Czech. J. Phys.; 21: No. 8, 860-77(1971).

The alloying behavior of 40 binary nickel alloy systems was studied in order to determine the extent to which the Hume–Rothery alloying rules apply. An attempt was made to utilize computer facilities in seeking trends of systematic relationships among the various nickel alloys. The nickel-rich parts of the binary-alloy phase diagrams were considered. (auth)

9813 CRYSTALLIZATION OF Ni–Zr ALLOYS DURING HIGH COOLING RATES. Varich, N. I.; Petrunina, A. N.; Yakunin, A. A. Izv. Akad. Nauk SSSR, Metal.; No. 5, 111-12 (Sep-Oct 1971). (In Russian).

Cooling of Ni–Zr alloys was studied at cooling rates of 10^7 to 10^8 degrees/sec. The region of homogeneous solid solutions could be enlarged to 6.9% at. % Zr. At very high concentrations of Zr in the alloys a phase Ni_3Zr separated out at the boundaries of dendritic cells of solid solution. (tr-auth)

Radiation Effects

Refer also to abstracts 10044, 10266, 10268, 10299, 10300, 10308, 10310, 11329, and 11330.

9814 (AI-AEC-13012) SWELLING AS A FUNCTION OF DISPLACEMENT DAMAGE IN PROTON-IRRADIATED TYPE 316 STAINLESS STEEL. Keefer, D. W.; Pard, A. G.; Kramer, D. (Atomics International, Canoga Park, Calif.). 15 Nov 1971. Contract AT(04-3)-824. 23p. Dep. NTIS.

Specimens of Type 316 stainless steel containing between 2 and 9 appM of preinjected helium, were proton irradiated at 500 and 600°C. Electron microscopy was used to determine volume swelling in specimens having undergone between 0.5 and 50 displacements per atom. Displacements were calculated from the Kinchin–Pease model with a threshold energy of 25 eV. Swelling at 500°C increased with damage up to about 25% for 50 displacements per atom. No evidence of a limit to swelling with increasing fluence was observed. The minimum void size increased with damage, and the void density increased with atom displacement rate. These results imply completion of nucleation early in the irradiation,

followed by continued void growth. A specimen having undergone 100 displacements per atom at 500°C exhibited a void array which was so complex that a swelling determination could not be made. Ferrite, transformed from austenite during the irradiation, was detected in this specimen by electron diffraction as small crystallites within the austenite grains. Evidence of austenite-to-ferrite transformation was obtained for specimens with about 5 or more displacements per atom. A specimen irradiated to about 20 displacements per atom at 600°C exhibited frequent joining of voids to form a complex array. Preliminary examination indicated swelling at 600°C is greater than at 500°C. Voids were larger and less numerous at 600°C. (auth)

9815 (BLG-459) EVALUATION OF THE BR3 THIRD CORE VESSEL STEEL SPECIMENS. De Meester, P.; Van Asbroeck, Ph.; Van De Velde, J.; Van Loon, C.; Laurent, L. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Jul 1971. 18p. Dep. NTIS (U. S. Sales Only).

These samples have been tested after irradiation. The shift in N.D.T. was 30 ft-lb for samples being irradiated for an integrated dose up to 8.5×10^{20} nvt is 305°C. Considering the sample positions, it can be concluded that in the BR 3 vessel after Vulcain core 2bis, brittleness could occur in the temperature range 60 to 95°C, and after Vulcain core 3 in the temperature range 70 to 100°C. It should therefore be preferable to avoid high pressure and specially sharp pressure transients even at relatively low absolute pressures, below that given temperature range increased by a safety factor. (auth)

9816 (BMI-1914) PROGRESS ON LMFBR CLADDING, STRUCTURAL, AND COMPONENT MATERIALS STUDIES DURING JULY 1970 THROUGH JUNE 1971. Annual Report, Task 32. Final Report, Task 14. Keller, Donald L. (Battelle Columbus Labs., Ohio). Jul 1971. Contract W-7405-eng-92. 183p. Dep. NTIS.

Results of DRDT-supported studies on cladding, component, and structural materials of interest for LMFBR applications. Low-cycle strain-controlled fatigue tests were conducted on both Incoloy 800 and Type 304 stainless steel. The fatigue tests on Incoloy 800 were run at 1000, 1200, and 1400°F. Creep-rupture tests were conducted on Incoloy 800 at 1400°F to complement the fatigue data obtained on this material. A least-squares Larsen-Miller parameter analysis of the Incoloy 800 creep data available in the literature was performed. The low-cycle strain-controlled fatigue tests conducted on Type 304 stainless steel specimens were run at 1000 and 1200°F. It was found that specimens tested with tension hold times had appreciably lower fatigue lives than specimens tested with no hold times. In addition to these tests, a series of tests was run on Type 304 stainless steel specimens to determine the influence of the amount of fatigue damage at 1000 and 1200°F under more complex loading conditions. Effects of irradiation, at various temperatures and fluence levels in the ETR, on the mechanical properties of a number of alloys are discussed. The alloys included Type 347 and 348 stainless steel, UMCo-50, Haynes Stellite 25, Tenelon, and nickel. Irradiations were carried out at 50, 400, and 650°C with the fast fluences ranging from 1.4×10^{21} to 3.0×10^{22} nvt. Tensile, fatigue, impact, and creep tests were performed on selected specimens. Tensile tests were performed on as-irradiated specimens as well as on specimens that had been irradiated and annealed. It was found that irradiation-produced displacement-type damage, which causes large changes in mechanical properties at low test temperatures, can be removed by annealing at elevated temperature. It was found also that changes in mechanical properties are a maximum for irradiation at 400, intermediate for irradiation at 50, and smallest for irradiation at 650°C. At 450 to 600°C, depending on material, all materials tested underwent a loss of ductility. This ductility loss could not be restored by postirradiation annealing at temperatures up to 1350°C. The influence of nickel on the elevated-temperature embrittlement was investigated. It was found that nickel was not necessary for the embrittlement but alloys containing nickel underwent the most severe losses in ductility because of high helium generation as a result of thermal-neutron reactions with nickel. Both fatigue life and stress-rupture life at 650°C were significantly reduced as a consequence of the irradiation-induced elevated-temperature embrittlement. Tensile tests were performed on Type 347 and Type 348 stainless steel specimens that were irradiated in the EBR-II at 400 and 650°C to fluences ranging up to 3.9×10^{22} nvt ($E > 0.1$ MeV). The tensile tests were performed at temperatures ranging from 25 to 750°C and were performed on as-irradiated specimens as well as on irradiated and annealed specimens. Results of tensile tests indicated that ductility was decreased and strength was increased by irradiation at 400°C for all testing temperatures. The mechanical properties of Types 304 and 316 stainless steel were determined after the specimens had been shock strengthened by means of either a flyer plate or contact explosives. Shocking was found to significantly increase the yield strength and proportional limit, moderately increase the ultimate strength, and generally decrease the ductility, although an intermediate increase in ductility with increasing shocking pressure was noted in material shock strengthened by means of a flyer plate. The magnitude of the change in tensile properties increased with shocking pressure (80 to 320 kbar) and held for all testing temperatures. The microstructure of shock-strengthened austenitic stainless steel exhibited fine striations when examined by light microscopy, while a high dislocation density and mechanical twins were identified by transmission electron microscopy. Impact properties of shock-strengthened Type 316 stainless steel were determined by instrumented Charpy impact tests. The material was shocked at room temperature by a pressure of 80 and 160 kbar and at 445 and 665°C by a pressure of 320 kbar. Increase in shocking pressure resulted in progressively lower values of energy required for fracture and of fracture toughness (K_c). The critical crack length also decreased with shocking pressure, with the critical crack length of the shocked material being independent of testing temperature. A variety of creep-rupture results were obtained on ferritic 2-¼ Cr-1 Mo alloy materials containing 0.012 and 0.042 wt % carbon. Larson-Miller plots of available stress-rupture data for these and commercial materials indicate a sequential reduction in rupture life with decrease in carbon content for applied stresses below about 13,000 psi for the 0.012 wt % carbon material and below about 15,000 psi for the 0.042 wt % carbon material. At higher stresses, although still below the yield strength, the low-carbon alloys apparently undergo strain hardening; resultant increases in rupture life produce a sharp break in the Larson-Miller plot for these alloys. The creep constants indicate that the creep strength of the 0.042 wt % carbon material is greater than that of the 0.012 wt % carbon alloy. (auth)

9817 (BNWL-SA-4114) HYBRID COMPUTER SIMULATION OF RADIATION DAMAGE ANNEALING IN METALS. Burnett, R. A. (Battelle Pacific Northwest Labs., Richland, Wash.). 22 Oct 1971. Contract AT(45-1)-1830. 24p. (CONF-711025-2). Dep. NTIS.

From Northwest simulation council conference; Richland, Wash. (29 Oct 1971).

Results of activities directed to studies by computer simulation the defect clustering characteristics of γ-iron, a stand-in for the stainless steel used in fact reactors, under various simulated environmental conditions are described. An α-iron model was also simulated. The technical results and implications of these studies were reported previously. A detailed description of the computer programs and simulation techniques which were applied is presented. (auth)

9818 (CEA-R-4134) DEFECTS INTRODUCED INTO Be AND Mg BY IRRADIATION AND COLD WORKING AT LOW TEMPERATURES. Nicoud, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jul 1971. 154p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

The creation of defects in Be and Mg by electron and neutron irradiation or by cold working at low temperatures, and the recovery from these defects were studied using various experimental techniques (electrical resistivity, stored energy, internal friction, and electron microscopy). The curves representing the defects created by irradiation exhibit a saturation with increasing dose. Recovery from the irradiation defects occurs in very different ways for the two metals. The process is discussed in terms of classical models proposed for fcc metals. The introduction of defects into Be and Mg by cold working at low temperatures leads to an increase in the electrical resistivity with the deformation which is similar to that observed in other cph metals and much larger than that observed with fcc metals. The recovery from these defects for the two metals occurs in a complex manner between 77 and 500°K. Cold worked Be undergoes large changes in the dislocation lattice between 300 and 500°K. (France)

9819 (CEA-R-4221) STUDY BY TRANSMISSION ELECTRON MICROSCOPY OF POINT DEFECTS INTRODUCED BY QUENCHING OR IRRADIATION IN TUNGSTEN. Brenac, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug 1971. 135p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

The quenching of tungsten at 3000°C with pure gallium in a high vacuum led to the formation of vacancy loops after subsequent annealing at 800°C. Fast neutron and fission fragment irradiations

were carried out on the same metal; the resulting perfect dislocation loops were analyzed, and it is shown that the relation between the loop density and the fluence of particles is strongly dependent on the shape of the samples (either bulk material, or thin foil). The difficulty of nucleating vacancy clusters is demonstrated and discussed. A model describing the nucleation of loops in the presence of an applied uniaxial stress is presented. The favoring of the artificial nucleation of anomalous loops (i.e., with a ⟨100⟩ Burgers vector) is considered, as well as the stress induced anisotropy involved in the nucleation of loops with equivalent vectors. An apparatus for irradiating under an applied stress is described. (France)

9820 (ORO-3612-8) INVESTIGATION OF IRRADIATION STRENGTHENING OF B.C.C. METALS AND SOLID SOLUTIONS. Progress Report, January–October 1971. Arsenault, R. J. (Maryland Univ., College Park. Dept. of Chemical Engineering). Contract AT(40-1)-3612. 115p. Dep. NTIS.

Research results are presented on effects of irradiation damage on the low-temperature deformation characteristics of bcc metals, low-temperature deformation of V–Ti alloys, fracture behavior of V–1.31 at. % Ti alloys, scavenging in V–Ti alloys, effects of O on relaxation strength of V, and effects of short-range barriers on dislocation. (J.R.D.)

9821 (WCAP-7036) CONNECTICUT YANKEE REACTOR VESSEL RADIATION SURVEILLANCE PROGRAM. Yanichko, S. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr 1967. 45p.

The purpose of this program is to obtain information on the effects of radiation on the Connecticut Yankee reactor vessel materials under operating conditions. Charpy V-notch impact specimens, tensile specimens and Wedge Opening Loading specimens were machined from three 10-½ inch shell plates from the center shell course adjacent to the core region of the Connecticut Yankee reactor vessel and weld metal from a weldment joining two upper shell course plates. The results of Charpy V-notch impact tests, tensile tests and Wedge Opening Loading tests on unirradiated Connecticut Yankee reactor vessel material are given. Charpy impact, tensile and Wedge Opening Loading specimens will be inserted into eight material test capsules to be located between the thermal shield and the vessel wall and positioned opposite the center of the core. The identification of the specimens and their locations in the test capsules are given. Post-irradiation testing of the Charpy impact specimens will provide a guide for establishing pressure-temperature limits of the plant considering the presently used conservative margin for the nil-ductility-transition temperature (NDTT) concepts. The post-irradiation test results on the Wedge Opening Loading specimens will provide applied stress values considering defect size and temperatures. The knowledge of these parameters could be used by design engineers to determine more specific limits for startup and operating procedures for nuclear reactors than those obtained with NDTT concepts. (auth)

9822 ENERGY DEPENDENCE OF ELECTRON-INDUCED RADIATION DAMAGE IN TUNGSTEN. Dicarlo, James A. (Lewis Research Center, Cleveland); Stanley, James T. Radiat. Eff.: 10: No. 4, 259-72(Sep 1971).

The energy dependence of low dose damage production in commercial and high purity polycrystalline tungsten wires was studied near 350°K with 1.6 to 2.4 MeV electrons. From resistivity measurements at 291°K the threshold energy for the onset of observable damage was determined as 50 ± 2 eV. An "effective" threshold of 52 ± 2 eV was also determined by directly fitting the energy dependence of the damage rates to theoretical displacement cross sections calculated from step-function displacement probabilities. A decrease of two orders of magnitude in impurity content reduced damage rates by about a factor of two but did not affect threshold. These results combined with current defect recovery models for tungsten, low temperature threshold data, and computer-calculated bcc damage theory suggest: (1) Observed damage consisted of equal concentrations of vacancies and impurity-trapped Stage I free interstitials. (2) Across Stage II (100°K to 600°K) onset threshold should be within 50 ± 2 eV. (3) Minimum recoil energy required for free interstitial production near 0°K is 53 ± 5 eV. (4) Threshold has little dependence on crystal direction. An empirical method is presented for predicting threshold energies in the bcc transition metals by assuming the directional dependence of threshold is directly proportional to that of Young's modulus. By the use of one universal proportionality constant (1.2×10^{-11} eV. cm^2/dyne), thresholds for a number of metals and directions are calculated and shown to have significantly better agreement with experiment than the best available theoretical estimates. (auth)

9823 ELECTRON BEAM INSPECTION OF TANTALUM THIN FILMS. Dugan, A. E. (Western Electric Co., Inc., Princeton, N. J.). pp 563-74 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

The secondary electron and backscattered electron emission properties of sputtered β tantalum and bcc tantalum thin films were measured for primary electron energies $0.2 \leq E_p \leq 2.0$ keV. The backscattered electron emission coefficient η was found to be similar for the two phases of tantalum. η increased from 0.25 at $E_p = 0.2$ keV to 0.41 at $E_p = 2.0$ keV. However, the secondary electron emission coefficients δ differed appreciably for the two phases. δ was found to be larger for β tantalum over the primary electron energy range investigated. The maxima in the secondary electron emission curves occurred at $E_p = 0.4$ keV for both phases with $\delta_{max} = 2.67$ for β tantalum and $\delta_{max} = 2.32$ for bcc tantalum. Measurements of the secondary electron energy distributions revealed maxima at ~4 eV for both tantalum phases. A simple low-energy scanning electron-beam inspection system was constructed. It resembles a scanning electron microscope in that it utilizes an electron beam as a probe. The electron beam is produced with a commercial CRT electron gun. Scanning electron micrographs were obtained of sputtered β tantalum thin films using this inspection system. These micrographs revealed the presence of bcc tantalum as well as other defects. (auth)

9824 COOLANT AND MATERIALS FOR REACTORS: PRESSURIZED WATER REACTORS. Maekawa, T. (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). Genshiryoku Kogyo: 17: No. 3, 27-31(Mar 1971). (In Japanese).

Primary and secondary coolants in PWRs are separately controlled. The secondary coolant, which is not in contact with reactor core, has less possibility of radioactive contamination, and secondary system instruments can be treated similar to those in non-nuclear power plants. The primary coolant is controlled by chemical shim method. In the primary system phenomena such as fission product production and transfer into the coolant, corrosion, and radioactivation of materials are found. These phenomena come to light, depending upon radiation level, in the primary coolant and in the amounts of radioactive wastes. The radiation level in the primary system, though it has no effect on reactor operation, should be as low as possible. It was established that materials in the primary system are minimally corroded by boron oxide and in order to inhibit the corrosion of materials further, LiOH is added. Oxygen concentration, which is restrained by addition of hydrogen gas, is so low that there is no possibility of stress corrosion cracking. No accident has been reported with regard to the chemical shim system. PWRs are so designed that the reactors can be safely operated even when one percent of the fuel is damaged, also the radiation level is much lower than the design limit. This indicates the high safety levels of PWR plants. (Japan)

9825 BEHAVIOR OF HELIUM GAS BUBBLES IN NEUTRON-IRRADIATED BERYLLIUM. Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokai); Ohashi, Shozo; Kawasaki, Satoru; Karita, Yoichi; Tsuno, Nobuo. J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 546-52(Oct 1971).

Transmission electron microscopic observations were made on hot-rolled Be sheet prepared from cast ingots irradiated to about 5×10^{19} nvt (fast) in JRR-2. The aim of the study was to elucidate the effect of irradiation on changes in microstructure and the effect of pre-irradiation heat treatment on the formation of He gas bubbles during post-irradiation annealing. The formation and growth of He bubbles during post-irradiation annealing was distinctly less inhibited in the Be irradiated as hot-rolled than in the metal irradiated after recrystallization treatment. In the first case, He bubbles could be observed upon post-irradiation treatment of only 3 hr at 750°C, while in the second case, a similar formation of bubbles could only be seen after a final treatment at 900°C for 50 hr. The difference thus observed in the tendency of bubble formation depends upon the grain boundary mobility during post-irradiation heat treatment. The nucleation and growth of bubbles occurred preferentially at the grain boundaries, inclusions and dislocation sites. The recrystallization of irradiated Be was retarded by the interaction between dislocations and He atoms. The inclusion which has the largest affinity to the bubbles in Be is $Be_{11}Fe$. (auth)

9826 RADIATION DAMAGE IN COPPER NEAR THE THRESHOLD ENERGY. Pruitt, A. B.; Chaplin, R. L. (Clemson Univ., S. C.). Radiat. Eff.: 10: No. 4, 235-7(Sep 1971).

Radiation damage and annealing studies of copper samples were performed for the near threshold energy region. A nonlinear be-

havior of the damage rate vs irradiation fluence is found. This effect is related to damage which does not anneal below 300°K and is independent of subthreshold damage. (auth)

9827 CORRELATION OF MICROSTRUCTURE AND STRENGTH DURING STAGE III ANNEALING OF IRRADIATED VANADIUM. Smidt, F. A. Jr. (Naval Research Lab., Washington, D. C.). Radiat. Eff.; 10: No. 4, 205-14(Sep 1971).

The microstructure of vanadium irradiated to a fluence of 1.0×10^{19} n/cm^2 E > 1 MeV at a temperature of 55°C was quantitatively analyzed after irradiation and post-irradiation annealing and correlated with changes in the strength as determined from microhardness measurements. Radiation anneal hardening during Stage III annealing was not accompanied by a change in the size or number of defect aggregates. It is shown that the strength changes and migration kinetics of Stage III are consistent with the migration of oxygen and/or carbon to the defect aggregates. It is suggested that the simultaneous observation of no growth of defect aggregates and radiation anneal hardening in Stage III can be used to differentiate between impurity migration and intrinsic defect migration. (auth)

9828 INTERACTION OF POINT DEFECTS WITH AND ON DISLOCATIONS IN ELECTRON-IRRADIATED PLATINUM. Snead, C. L. Jr.; Peters, P. B.; Goland, A. N. (Brookhaven National Lab., Upton, N. Y.). Radiat. Eff.; 10: No. 4, 219-25(Sep 1971).

Polycrystalline and ⟨100⟩-oriented single-crystal wires of high-purity platinum were irradiated with 2.5 MeV electrons at ~20°K and above liquid-nitrogen temperature. Following each irradiation, measurements of the logarithmic decrement were taken as a function of temperature. In general, the irradiations resulted in pronounced pinning and depinning effects as well as anelastic effects due to the irradiation-produced interstitials alone. The former are interpreted as, on the one hand, pinning of dislocations by interstitials which arrive at the dislocations and are immobilized, and on the other hand, the annihilation of pre-existing vacancy pinners by interstitials that become mobile on the dislocations. An increase in the decrement at a temperature of ~75°K was observed in both samples, and this increase is related to the onset of interstitial pipe diffusion which brings about the mutual annihilation of the interstitial and vacancy pinners. In addition to some structure in the background, a reorientation peak attributed to anelastic reorientations of interstitial-type defects was observed at ~38°K. The excessive width of the observed peak suggests a spectrum of activation energies associated with the peak. From the results of the experiments it is asserted that conclusions based upon pinning rates must take into account the possible interaction between newly arrived interstitial pinners and pre-existing vacancy pinners. These interactions will be temperature dependent and may profoundly influence low-flux, low-fluence irradiation experiments. (auth)

9829 SUBTHRESHOLD EVENTS AND ATOMIC DISPLACEMENTS IN ELECTRON-IRRADIATED CADMIUM. Maury, F.; Vajda, P.; Lucasson, A.; Lucasson, P. (Paris Univ., Orsay, France). Radiat. Eff.; 10: No. 4, 239-45(Sep 1971).

High-purity zone refined specimens of cadmium were irradiated at liquid helium temperature with electrons in the energy range 0.5 to 1.7 MeV. From the measurements of the electrical resistivity change rate per incident electron and from an analysis of the recovery spectra up to ~200°K it is deduced that two simultaneous processes are acting under electron bombardment. The first—a subthreshold process—is of a complicated nature and thought to be due to the interaction of the bombarding electrons with very small amounts (~10^{-7} per atom) of hydrogen atoms loosely bound to traps, their binding energy being of the order $T_s \sim 10^{-1}$ eV. The second is the cadmium atom displacement proper, with an energy threshold of $T_d = 19 \pm 2$ eV. (auth)

9830 CHANGES OF TENSILE PROPERTIES IN COPPER–BERYLLIUM ALLOYS DURING IRRADIATION AND POST-IRRADIATION AGEING. Yoshida, Hiroyuki; Kodaka, Hisao; Miyata, Kiyomi. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 119-22(1971).

In order to study enhanced γ' precipitation in irradiated Cu–2.0 wt % Be alloy, tensile properties (flow stress, elongation, tensile strength) were measured during irradiation at doses up to ~1.6×10^{19} nvt. The effects of aging up to 250°C were also determined. Stress–strain curves were used to study the appearance of partially and fully coherent Guinier–Preston zones and precipitates. (D.L.C.)

9831 HELIUM GENERATION IN STAINLESS STEEL AND NICKEL. Bauer, A. A.; Kangilaski, M. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. J. Nucl. Mater.; 42: No. 1, 91-5(Jan 1972).

Helium contents of up to 2000 ppM atomic have been measured in stainless steel specimens irradiated in the ETR. Thermal neutron reactions were identified as the source of the helium. Specifically, the helium is generated by a $^{59}Ni(n,\alpha)^{56}Fe$ reaction that is preceded by the ^{58}Ni to ^{59}Ni neutron capture reaction. The cross section calculated for the (n,α) reaction, which has not been previously reported, is 7.38 barns. Experimentally, the helium content was observed to increase as the square of the fluence, i.e., $N_{He} \propto (\phi t)^2$. It is estimated that this dependence gradually changes above a fluence of 10^{23} n/cm^2 to a linear dependence (i.e., $N_{He} \propto \phi t$) that becomes effective above about 10^{25} n/cm^2. (auth)

9832 MECHANISM OF RADIATION ENHANCEMENT OF ZIRCONIUM ALLOY OXIDATION: IMPLICATIONS OF NEW DATA. Shirvington, P. J. (Australian Atomic Energy Commission, Lucas Heights). J. Nucl. Mater.; 42: No. 1, 108-12 (Jan 1972).

The fact that results have been obtained to show that the out-of-reactor enhancement of oxidation of Zircaloy-2 and some other Zr alloys in pressurized water by high concentrations of O is both real and large has been used to derive a relatively simple chemical explanation of radiation enhanced oxidation of Zr alloys which does not require radiation damage in the oxide or metal. The results obtained explain enhanced oxidation of Zircaloys in boiling water reactors. The fact that the enhancements do not occur in pressurized water reactors, which operate with 0.01 ppM oxygen and 5 to 50 cm^3 H_2/kg H_2O may mean that a critical coolant oxygen to hydrogen ratio must be reached before conditions inside the oxide become highly oxidizing. (P.C.H.)

9833 DEPTH DISTRIBUTION OF ENERGY DEPOSITION BY 4 TO 40 MeV Fe^+ INCIDENT ON Fe. Brice, D. K. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 11: No. 1, 51-4 (Oct 1971).

The depth distribution of energy deposited into atomic processes was calculated for Fe ions incident on an amorphous Fe target with incident energy in the range 4 to 40 MeV. The results of this calculation are of basic importance in ion implantation simulation studies of the radiation damage of stainless steel cladding on power reactor fuel elements. (auth)

9834 STUDY OF THE STAGE III RECOVERY OF ELECTRON IRRADIATED ALUMINUM. Brugiere, Regis; Lucasson, Pierre (CNRS, Orsay, France). Radiat. Eff.; 11: No. 1, 55-7(Oct 1971). (In French).

The nature of the electron bombarded aluminum electrical recovery process was studied by combining quenches with irradiations. Measured Frenkel pair formation rates per incident electrons as well as annealing kinetics emphasize the role of impurity interstitial trapping. (auth)

9835 ELEVATED-TEMPERATURE DAMAGE FUNCTIONS FOR NEUTRON EMBRITTLEMENT IN PRESSURE VESSEL STEELS. Serpan, C. Z. Jr. (Naval Research Lab., Washington, D. C.); McElroy, W. N. Nucl. Technol.; 13: No. 2, 185-93(Feb 1972).

Damage functions, represented here as multigroup cross sections for neutron-induced radiation damage production, were derived for irradiation of two A350-series ferritic steels at temperatures of 510 and 430°F, representing the PM-2A and SM-1A reactor pressure vessels. The functions were derived using the SAND-II computer code with the neutron spectra and resulting increases in transition temperature from a series of irradiations in different reactor locations. The derived damage functions effected a best correlation of available data, and on that basis are considered good through comparison of total fluence values determined both from experimental measurements and from the damage-function-calculation technique. Trends are suggested for the magnitude of damage function cross section values as a function of energy at low versus elevated temperatures. However, the experimental data are not sufficiently definitive to draw positive conclusions about the specific contributions of neutrons of all energy levels to the neutron embrittlement process. (auth)

9836 EFFECT OF NEUTRON IRRADIATION ON STRUCTURE AND MICROHARDNESS OF DIFFERENT FACES OF A MOLYBDENUM SINGLE CRYSTAL. Grishkov, G. N.; Mavridi, D. I.; Klein, G. A. pp 171-5 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The effect of neutron irradiation (integral flux 2×10^{18} neutrons/cm^2 over a period of 30 hr) on the structure and physicomechanical properties of various faces of a Mo single crystal prepared from a sintered compact by electron-beam zone melting was studied. Considerably greater microhardness developed, particularly

on the (111) face, as a result of irradiation. The change was attributed to the creation of obstacles preventing the free motion of dislocations (vacancies, interstitial atoms, and dislocation aggregates constituted the most important forms of such obstacles). (Metals Abstr.)

Ceramics and Cermets

Refer also to abstracts 9216, 9688, and 9689.

Corrosion and Erosion

9837 (MDC-G-3129) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 12, July-September 1971. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Oct 1971. Contract AT(45-1)-2138. 36p. Dep. NTIS.

Evaluation of plutonia/barrier material/iridium container test combinations after exposure at 1500°C for 1000 hours suggests that the barrier materials tested be eliminated. Hafnia, one of the barrier materials, contributed excess oxygen to the system causing molybdenum, another barrier material, to vapor transport to cold surfaces and then react with the iridium. Stoichiometric plutonia appears to have better compatibility with iridium in these complex tests but poorer geometric stability than substoichiometric plutonia. Testing of a plutonia/iridium system is required for substantiation. Further exposure is underway with matched samples and additional noble-metal containers. Results on plutonia molybdenum cermet (PMC)/refractory-alloy double containers exposed at 1500, 1800, and 2000°C reported in the 11th Quarterly Report (MDC G3124, July 1971) were generally confirmed by microhardness measurements. Further exposure continues at 1500 and 1800°C. Curia-244/refractory alloy specimens completed 1800°C-12,000 hour and 2000°C-10,000 hour exposures and are ready for examination. Preparations have been made to encapsulate four sets of plutonia and plutonia/curia-242 fuel bodies to determine the effects of helium generation on the thermal and mechanical stability of PMC and pressed plutonia (PPO) fuel forms. (auth)

9838 PROBLEMS CONCERNING CORE MATERIALS FOR HIGH-TEMPERATURE GAS-COOLED REACTOR. Suzuki, H. (Tokyo Inst. of Tech.). Genshiryoku Kogyo; 17: No. 7, 32-7 (Jul 1971). (In Japanese).

Reactors with graphite moderators seemed to decline at one time, but development of cladding material with carbon as a main constituent for fine-particle fuel used with helium coolant, suddenly attracted attention because of improvement of thermal efficiency owing to attainment of high temperature and high burnup, effective utilization of nuclear resources by adoption of the thorium cycle, and direct utilization of nuclear thermal energy. Experimental HTGRs were completed, and operational experiences were accumulated in the U. K., U. S. A. and West Germany. Future course of the HTGRs must be decided in terms of power generation cost, techniques for effective use of high-temperature helium, and reprocessing of spent fuel. In order to raise the outlet temperature of helium, a temperature rise in the coated particle fuel is necessary in addition to design improvement leading to even temperature distribution in the core, and He velocity increase. However, cracking of the coating, reaction of the coating with kernels, changes of shape, changes of dimension, and changes of properties of graphite under high temperature irradiation cause problems that necessitate further studies. (Japan)

9839 ELECTRON-MICROSCOPIC INVESTIGATION OF THE REACTION OF WATER VAPOR WITH SINGLE CRYSTALS OF GRAPHITE. II. INHIBITION BY HYDROGEN. Montet, G. L.; Myers, G. E. (Argonne National Lab., Ill.). Carbon; 9: No. 5, 673-9(Oct 1971).

The earlier study of the graphite-water vapor reaction was extended to the inhibition of the reaction by hydrogen. The apparatus and technique were essentially those used in the earlier study. It was found that very low concentrations of hydrogen, less than 1 vpm, inhibit the reaction to an appreciable extent. The order of the reaction with respect to hydrogen was found to be near $-\frac{1}{2}$, indicating that the effect is produced by a dissociative adsorption. The apparent activation energy for the reaction increases with increasing hydrogen concentration, as does the pre-exponential factor in the Arrhenius equation; thus, the inhibition exhibits the "compensation" effect. The effective concentration of the hydrogen produced in the reaction when no hydrogen is added deliberately can be calculated from the data and is found to be equivalent to about 0.1 vpm of hydrogen. (auth)

Preparation and Fabrication

Refer also to abstracts 9075, 9080, 9095, 9707, 11422, 11424, and 11425.

9840 (70-CNA-656) SOME VIEWS ON THE CONTRIBUTION OF FUEL FABRICATORS TO THE CANADIAN NUCLEAR INDUSTRY. Durant, W. C. (Canadian General Electric Co., Ltd., Peterborough (Ontario)). 1970. 11p. (CONF-700564-4). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Discussions are presented on the role of fabricators in development and application of manufacturing processes to the production of power reactor fuel. Examples are given to illustrate development of special fabrication techniques, application of efficient processes, and operation of quality control systems. (J.R.D.)

9841 (AE-415) INFLUENCE OF POWER CHARACTERISTICS ON PROCESS AND PRODUCT PARAMETERS IN UO_2 PELLETIZATION. Runfors, U. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Apr 1971. 33p. Dep. NTIS (U. S. Sales Only).

The relations between the powder properties and the different steps in the pelletizing process as applied to uranium dioxide were examined. The results showed that, no simple correlations exist between powder properties and the properties of the final product. Powder metallurgy or the entire pelletizing process can be understood, if the influence of powder properties on the partial processes of powder metallurgy and on the intermediate products are clarified and then integrated. This can be achieved if process variables as well as powder and product porperties are chosen in a meaningful way and if a sufficient number of powder properties are kept constant, which is difficult in powder metallurgy. This integrated approach contains the possibility of studying powder metallurgy as an optimization problem, technically as well as economically. (auth) (Sweden)

9842 (HEDL-SA-262) HOT PRESSING OF BORON CARBIDE IRRADIATION TEST SPECIMENS. Ross, W. A. (Hanford Engineering Development Lab., Richland, Wash.). 1 Oct 1971. Contract AT(45-1)-2170. 17p. (CONF-711030-4). Dep. NTIS.

From twenty-fourth Pacific Coast regional meeting of the American Ceramic Society; Anaheim, Calif. (30 Oct 1971).

A system is described for hot pressing boron carbide to any desired density greater than 65% theoretical. It was found that grain sizes can be modified by selection of starting particle size and by annealing near the melting point. The B/C ratio can be lowered by addition of graphite powder. (J.R.D.)

9843 (INIS-mf-55) TECHNICAL DEVELOPMENT OF THE FUEL RODS FABRICATION. Koll, J. H.; Biondo, C. D. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 14p. (In Spanish). (CONF-701124-4). INIS.

From Metallurgical meeting; Cordoba, Argentina (Nov 1970).

The development of techniques applied to the fabrication of fuel rods with core of UO_2 pellets and Zircaloy-4 (Zr-1.5% Sn) sheathing is described. For the fabrication of the fuel rods, various techniques are used; among them are powder metallurgy, machining, welding, surface treatment, and quality control. Quality control must satisfy very rigid specifications with good reproducibility because of the high cost of fabrication. The techniques described are not of exclusive nuclear application, but can be used in similar non-nuclear fabrications where equally high quality is required. (tr-auth)

9844 (INIS-mf-57) FABRICATION OF UO_2 FUEL CERAMIC PELLETS. Dyment, I. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 9p. (In Spanish). (CONF-701124-3). INIS.

From Metallurgical meeting; Cordoba, Argentina (Nov 1970).

The fabrication of UO_2 compacts, a critical step because of the poor characteristics of the powder during compacting, is described. The other fabrication steps described include sintering and control of the specifications. The special care which must be taken during the procedure in order to avoid all possible contamination for materials in contact with the UO_2 is considered. (tr-auth)

9845 PREPARATION OF SAMARIUM, GADOLINIUM, AND DYSPROSIUM NITRIDES. Lyutaya, M. D.; Goncharuk, A. B. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 6, 1426-9(Jun 1971).

Translated from Zh. Prikl. Khim.; 44: No. 6, 1410-12(Jun 1971).

Two methods were studied for the preparation of Sm, Gd, and Dy nitrides. The results showed that in order to obtain nitrides of stoichiometric composition, nitriding of Sm, Gd, and Dy by the action of N must be conducted at temperatures close to the melting points of the metals. When ammonia was used as the nitriding medium, preparation of Sm, Gd, and Dy nitrides in a short reaction time (1 hr) also required the use of high temperatures, at which the hydrides formed were converted completely into nitrides. (P.C.H.)

9846 IMPROVEMENTS IN THE PREPARATION OF SINTERED URANIUM DIOXIDE GRAINS. (to General Electric Co.). British Patent 1,256,283. 8 Dec 1971. Priority date 29 Oct 1968, United States.

A method is described for the production of sintered UO_2 grains of controlled size for use as nuclear fuel. Uranium dioxide or ammonium diuranate powder is pressed into compacts and then sintered at a temperature of at least 1900°C until grains of UO_2 of the desired size are formed. The sintering is carried out in an atmosphere of dry hydrogen with a dew-point sufficient to produce sub-stoichiometric UO_2. The sintered compacts are then cooled in an atmosphere of hydrogen or an inert gas to precipitate metallic uranium at the boundaries of the grains, and when the temperature reaches about 400°C, the cooling is continued in a hydrogen atmosphere such that the precipitated metallic uranium reacts with the hydrogen to form uranium hydride, thereby causing the sintered compacts to disintegrate into substantially the grains of UO_2. The product is free-flowing and can be combined readily with other materials if desired. (P.C.H.)

9847 MANUFACTURING OF NUCLEAR FUEL ASSEMBLIES FOR THE DEUTERIUM CRITICAL ASSEMBLY. Morita, K.; Iwamiya, T. (Sumitomo Electric Industries Ltd., Osaka). Sumitomo Elec. Rev.; No. 103, 87-98(Jan 1971). (In Japanese).

The fabrication of 76 fuel assemblies of 1.2% enrichment and 6 fuel assemblies of 1.5% enrichment for the Deuterium Critical Assembly (DCA) in OHARAI Technical Center is described. Each fuel assembly consisted of 28 fuel rods arrayed concentrically. UO_2 pellets were sheathed in an aluminum tube with an outer diameter of 16.7 mm and a length of about 2,000 mm. Total UO_2 weight of these fuel assemblies was 8 tons (1.2% enrichment; 7.6 tons, 1.5% enrichment; 0.6 tons). Much useful information about the engineering and quality control techniques was gained through the manufacture of these fuel assemblies. (auth) (Japan)

9848 SOVREMENNYE NAPLAVOCHNYE MATERIALY NA OSNOVE TUGOPLAVKIKH SOEDINENII. (Modern Refractory Materials on the Basis of Refractory Compounds). Sheenko, I. N.; Oreshkin, V. D.; Repkin, Yu. D. Kiev; Izdatel'stvo Naukova Dumka (1970). 240p.

Theoretical and practical features of the melting process are discussed, with special reference to the alloying of refractory components. Properties and structures of refractory products such as carbides, borides, and silicides are examined in detail; the metallic constituents of these compounds include iron, chromium, titanium, and molybdenum. Such other compounds and high-melting alloys treated by the authors are ferromolybdenum, ferrovanadium, ferrotitanium, ferrochromium, boron carbide, titanium diboride, and composites of the latter two substances. Recommendations are made for the use of refractory materials, and for increasing their durability and wear-resistant qualities. 280 references. (K.S.W.)

9849 SOVREMENNYE PROBLEMY POROSHKOVOI METALLURGII. (Current Problems in Powder Metallurgy). Fedorchenko, I. M. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1970). 344p.

A collection of 27 articles by various authors is presented which is devoted to methodology and theory of producing various articles from powders of refractory materials. Milling and pressing of metal powders, the sintering of crystalline powders such as UO_2, and metallo-ceramic objects are considered in several chapters. Information on surface phenomena and frictional and antifrictional materials is presented. The last four chapters focus attention on thermodynamics and technology of UO_2 and ceramics in connection with nuclear fuels. (K.S.W.)

9850 PREPARATION OF CHEMICALLY REACTIVE URANIUM TRIOXIDE. Ballard, Roger K. (to United States Atomic Energy Commission). U. S. Patent 3,607,146. 21 Sep 1971. Filed 19 Jan 1970.

The chemical reactivity of uranium trioxide produced by the fluidized bed process is increased by adding a small amount of aluminum nitrate and a slight excess of nitric acid to the aqueous uranyl solution prior to denitration in a fluidized bed at a temperature of at least 400°C. (Official Gazette)

9851 CNEN'S ACTIVITIES IN NUCLEAR FUEL FABRICATION AT SALUGGIA. Boccalari, M.; Cacciari, A.; Gabaglio, M.; (and others). Com. Naz. Energ. Nucl.; Notiz.; 17: No. 8-9, 45-72(Aug-Sep 1971). (In Italian).

A review is presented of CNEN's activities in the field of fuel element fabrication. These activities are conducted by the Saluggia Fuel Element Fabrication and Control Laboratory. Elements of both proven design and advanced design, in particular those intended for the Cirene and PEC reactors, are described. (auth)

9852 ELECTROSLAG FUSION OF BORON CARBIDES AND SILICON ON STEEL. Svetlopolyanskii, V. I.; Oreshkin, V. D.; Repkin, Yu. D. Avtomat. Svarka; No. 10, 74-5(Oct 1971). (In Russian).

Results of a study are presented in which optimum boron carbide and silicon carbide compositions were selected for their steel wetting characteristics. The best compositions have wetting angles of 3 to 5°. The microstructures and hardness of SiC and B_4C coatings on steel were evaluated. (K.S.W.)

9853 CUSP PROCESS FOR PREPARING CONCENTRATED, CRYSTALLINE URANIA SOLS BY SOLVENT EXTRACTION. McBride, J. P.; McCorkle, K. H. Jr.; Pattison, W. L.; Finney, B. C. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 13: No. 2, 148-58(Feb 1972).

A new process for producing concentrated, 1 M U or more, crystalline urania sols by solvent extraction was developed. This process is based on a time-temperature-conductivity-controlled extraction of nitric acid from a hydrolyzing U(IV) nitrate-formate solution using an amine-in-hydrocarbon extractant. The sols contain predominantly crystalline urania, and are more resistant to rapid, spontaneous gelation and other variations in properties than earlier sols made by solvent extraction. Also, earlier solvent extraction processes produced dilute (0.2 to 0.3 M U) sols that required concentration to 1 M before making the spheres. The preparation of a satisfactory sol depends on ensuring crystallization of the urania, minimizing uranium oxidation and having a stable U(IV) nitrate-formate feed solution. Feed solutions were made by reducing uranyl nitrate-formate solution with platinum-catalyzed hydrogen at atmospheric pressure. The reduction requires vigorous agitation of the solution and continuous electrometric monitoring of the U(IV)/U(VI) redox potential to minimize harmful side reactions. (auth)

9854 PROCEDURE FOR FABRICATING A FUEL ELEMENT FOR A THERMIONIC CONVERTOR. Blum, Pierre; Moreau, Claude (to Commissariat a l'Energie Atomique). French Patent 2,054,485. 23 Apr 1971. Filed 11 Jul 1969. (In French).

A method for fabricating a fuel element for a thermionic converter is described. The nuclear fuel particles are successively coated with pyrocarbon and/or silicon carbide, covered with a layer of finely divided graphite (~micron size grains), and mixed with a graphite powder and a chemical binder. The mixture obtained is shaped and dried. The matrix is then impregnated with gaseous hydrocarbons at a temperature between 800 and 1100°C and covered with a layer of rhenium. (France)

9855 METHOD OF MANUFACTURING SINTERED SUBSTOICHIOMETRIC OXIDES. Dean, Guy (to Commissariat a l'Energie Atomique). French Patent 2,061,557. 25 Jun 1971. Filed 27 Jun 1969. (In French).

A method of manufacturing ceramic fuels, consisting of mixed substoichiometric dioxides of U and Pu, is described. A mixture (in powdered form) of the oxides and carbon is sintered, the appropriate proportions being used to obtain the required substoichiometry on eliminating oxygen in the form of CO. The sintered material is then crushed, before undergoing a second sintering in conditions identical to those of the first sintering. The sintering takes place between 1500 and 1800°C in a vacuum of at least 10^{-4} torr. (France)

9856 METHOD OF MANUFACTURING SINTERED URANIUM OXIDE FROM HEXAFLUORIDE. Artuad, Robert (to Commissariat a l'Energie Atomique). French Patent 2,060,242. 18 Jun 1971. Filed 19 Sep 1969. (In French).

A method of manufacturing UO_2 which is used in the sintered state for nuclear fuel pellets, is described. Vaporized UF_6 is reacted with steam at a temperature in excess of 100°C in the first section of a furnace; in order to prevent further action with the vaporized UF_6, the UO_2F_2 produced is removed immediately into the second section of the furnace, where it is transformed into UO_2. (France)

Properties Evaluations

Refer also to abstracts 8862, 8869, 9211, 9294, 9751, 9752, 10322, 10323, 10327, 10342, and 10343.

9857 (AECL-3791) FACTORS AFFECTING THE STRENGTH OF SELF-BONDED SILICON CARBIDES. Stevens, R.; Phillips, E.; Hutchings, W. G. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Aug 1971. 23p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The fracture strength of several different "self-bonded" silicon carbide materials was measured and the effects of variables such as microstructure, surface finish, mechanical testing technique, and specimen size examined. The criterion governing a useable stress at low probabilities of failure was found to be the reproducibility of properties rather than a high average fracture strength. From an analysis of the experimental data, deductions were made to optimize the fracture stress by a choice of suitable microstructures and surface finishes. (auth)

9858 (RT/MET-(71)1) APPLICATION OF ALPHA AND BETA-GAMMA AUTORADIOGRAPHY IN SHIELDED CELLS FOR THE EXAMINATION OF IRRADIATED NUCLEAR FUELS. Pugnetti, G.; Trezza, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 19 Oct 1970. 16p. INIS.

Techniques used at the Casaccia Hot laboratory for recording alpha and beta-gamma activities in samples of irradiated UO_2 and $UO_2 + PuO_2$ nuclear fuels are described. Fission products distribution was studied by beta-gamma autoradiography in connection with the problems of fission gas release and swelling of the fuel. Attention is also given to the relation between bands of activity and grain structure and to the chemical compatibility between fuel and structural materials. Alpha-autoradiography, on the other hand, is used as a control on mechanical mixtures of fissile materials and as a test of diffusion of the heavy elements. The trend of both techniques is towards more quantitative results; for this purpose interpretation of the autoradiographs is being performed by photometric and microscopic examinations. (INIS)

9859 BEHAVIOR OF CERTAIN RARE-EARTH HEXABORIDES AT ELEVATED TEMPERATURES IN AIR. Timofeeva, E. N.; Timofeeva, N. I. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 6, 1414-16(Jun 1971).

Translated from Zh. Prikl. Khim.; 44: No. 6, 1400-2(Jun 1971).

Studies on the stability of the hexaborides LaB_6, NdB_6, SmB_6, and DyB_6 at temperatures of 750, 850, and 950°C for prolonged periods in air showed that the oxidation products of the hexaborides are borates of the composition $Me_2B_5O_{10}$, melting in the region of 1150 to 1250°. (auth)

9860 REDUCTION OF γ-UO_3 BY CARBON MONOXIDE. Bessonov, A. F. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 6, 1419-21(Jun 1971).

Translated from Zh. Prikl. Khim.; 44: No. 6, 1404-6(Jun 1971).

A multipurpose assembly is described for simultaneous measurement of electrical resistance, linear dimensions, and thermal effects when a specimen is heated in a particular gaseous atmosphere. A qualitative picture is presented of the kinetics of phase transitions in the system γ-UO_3 during reduction by carbon monoxide with continuous heating. (auth)

9861 HARDNESS ANISOTROPY, DEFORMATION MECHANISMS AND BRITTLE-TO-DUCTILE TRANSITION IN CARBIDES. Rowcliffe, D. J.; Hollox, G. E. (Brown Boveri Research Center, Baden, Switzerland). J. Mater. Sci.; 6: No. 10, 1270-6(Oct 1971).

The slip plane for $TiC_{0.8}$, $VC_{0.84}$, and substoichiometric tantalum carbide was determined as {110} using microhardness indentation at room temperature. Under the same conditions, $HfC_{0.98}$ also slips on {110} but $TaC_{0.96}$ slips on {111}. At low temperatures {110} slip is characteristic of the Group IV and substoichiometric Group V transition metal carbides while stoichiometric Group V carbides probably deform preferentially on {111} at all temperatures. This behaviour is explained in terms of two models for the crystal structures of the carbides. The Group IV carbides are described by a close-packed metal lattice whereas the structure of stoichiometric Group V carbides is more open. Various physical and mechanical properties and the effects of changing carbon content were correlated on the basis of the models. In particular, an explanation of the brittle-to-ductile transition in carbides is proposed. (auth)

9862 PLASTIC FLOW AND FRACTURE OF TANTALUM CARBIDE AND HAFNIUM CARBIDE AT LOW TEMPERATURES. Rowcliffe, D. J.; Hollox, G. E. (Brown Boveri Research Center, Baden, Switzerland). J. Mater. Sci.; 6: No. 10, 1261-9(Oct 1971).

Knoop and Vickers hardness measurements were made on tantalum carbide and hafnium carbide single crystals. The hardness varied with orientation of the indenter in the crystal, but indentations in the two carbides were of very different character. TaC behaved in a relatively ductile manner and deformed plastically before cracking, while HfC exhibited extremely limited plastic flow and cracks on indentation. Moreover, the preferred slip plane was {111} in TaC but was {110} in HfC. These results are related to the reported physical properties of these carbides. In particular, the observed mechanical behaviour of TaC appeared to be consistent with the more metallic nature of this carbide. (auth)

9863 GIDRIROVANIE TITANOVYKH MATERIALOV. (Hydrogenated Titanium-Containing Materials). Rubtsov, A. N.; Olesov, Yu. G.; Antonova, M. M. Kiev; Naukova Dumka (1971). 128p.

The production, properties, and uses of Ti powder, Ti hydride, and Ti-Me-H are discussed, where Me may be one of the following metals: Zr, V, Cr, Mn, Fe, or Al. The refining of Ti and its alloys, and chemical behavior of such materials in various mineral acids and alkali are described. The phase diagram of the Ti-H system is presented and analyzed in detail. Other chapters focus attention on the electrolytic refining of Ti alloys, and the treatment of electrolytic slimes. The last chapter presents the thermodynamics of Ti hydrides and alloys with the metals listed above, and some results of x-ray studies. (215 references) (K.S.W.)

9864 ANNEALING OF NEUTRON-IRRADIATED PYROCARBONS. Price, R. J.; Bokros, J. C. (Gulf General Atomic Co., San Diego, Calif.). Contract AT(04-3)-167. Carbon; 9: No. 5, 555-72(Oct 1971).

A variety of pyrolytic carbons irradiated with fast neutrons to 1.5 to 2.4×10^{21} n/cm^2 (E > 0.18 MeV) at 540 to 1060°C were annealed at temperatures between 400 and 3000°C. Changes in density, linear dimensions, layer spacing, (002) peak width, electrical resistivity, and microhardness were followed. Recovery of all properties started at 1200 to 1600°C and occurred most rapidly at 2200 to 2400°C. For irradiation temperatures of 540 and 620°C the crystallite dimensions reverted to their pre-irradiation values, but for higher irradiation temperatures 60 to 80% of the crystallite dimensional change was unannealable. For samples irradiated at 890 to 1060°C, post-irradiation annealing reduced the layer spacing, (002) peak width, and electrical resistivity to below their pre-irradiation levels. The distributions of apparent activation energies for the annealing processes were calculated, assuming a single-valued preexponential factor. The calculations indicated an apparent activation energy of 5 to 5.5 eV for the earliest annealing steps, and a peak in the distribution function at ~8.5 eV. (auth)

9865 TECHNIQUE USING RESONANCE CAPTURE OF PROTONS TO STUDY OXYGEN DIFFUSION IN TITANIUM DIOXIDE. Lees, D. G.; Calvert, J. M.; Derry, D. J. (Univ. of Manchester, Eng.). pp 429-36 of Diffusion Processes. Vol. II. /Sherwood, John N. (ed.). London; Gordon and Breach Science Publishers Ltd. (1971).

From Proceeding of the Thomas Graham memorial symposium; Glasgow, Scotland (22 Sep 1969).

A technique for studying oxygen diffusion in single crystal TiO_2 by means of resonance capture in the reaction ^{18}O (p,α) ^{15}N is reported. The results from this technique were compared with those obtained using the ^{18}O (p,n) ^{18}F reaction and those derived by Haul and Dümbgen from isotope exchange measurements. (auth)

9866 IRREPRODUCIBILITY OF THE PROPERTIES OF COMPOUNDS OF VARIABLE COMPOSITION SUCH AS TiO, TaC, AND CdS. Ormont, B. F.; Smirnova, V. I. (Leningrad Electrotechnical Inst. Leningrad Technological Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 805-9(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 908-12(May 1971).

Irreproducibility of the properties of compounds of variable composition is more or less unavoidable unless special attention is paid to secondary details of the synthesis and the conditions of measurement of the properties, even if they are performed in the same laboratory. In the case of compounds of variable composition, the differences between the properties of quenched or annealed or partly annealed specimens (if equilibrium has been attained at the synthesis temperature), and the differences between the properties of specimens which have not attained equilibrium, may be unexpectedly great. The scatter in the values of the properties may be greater than the instrumental error of measurement of the properties by an order of magnitude or more. Discrepancies found in the data of different laboratories working

with different specimens, or even with the same specimens differently treated, do not justify isolated conclusions by one laboratory that their data are right and everybody else's are wrong. Combined verification and analysis of the results is needed. Planning and execution of such combined work would much reduce the amount of discussion about isolated results and the conclusions of different workers and (what is most important) would yield more reliable experimental material for the theory of compounds of variable composition. (auth)

9867 GRAPHITE FOR REACTORS. Sasaki, Yasuichi (Japan Atomic Energy Research Inst., Tokai). Tanso; No. 64, 14-21(Mar 1971). (In Japanese).

Since graphite has been used for CP-1 as far back as 1941, it has been used as moderators, reflectors and some parts of fuel rods for reactors in a variety of ways. At the same time, research to develop and to improve the graphite for reactors and research on radiation damage of the graphite has been pursued. A general idea of the graphite for reactors and a few fundamental matters which may be useful in considering behavior in the radiation damage of graphite are discussed. Also, recent studies on the radiation damage of graphite at high temperatures, which have been done to develop high-temperature gas-cooled reactors, were surveyed. First, generally desirable properties of the graphite for reactors, and secondly, properties of gilsonite graphite, which was especially developed for the Dragon reactor in England, are discussed. Lastly the properties of graphite from the standpoint of the radiation damage, i.e., general description and process of the radiation damage, and review of recent studies on the radiation damage at high temperature are described. (Japan)

9868 FRACTURE BEHAVIOUR AND ELECTRON MICROSCOPY OF A FINE GRAINED GRAPHITE. Stevens, R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Carbon; 9: No. 5, 573-8(Oct 1971).

Fracture surfaces of a fine grained isotopic graphite were examined using two stage plastic carbon replicas and scanning electron microscopy. In addition specimens were thinned by argon ion bombardment to obtain foils suitable for transmission electron microscopy, and a technique to observe completely enclosed pores is described. Large numbers of groups of microcracks were seen in the thin foil, which were found to occur in the basal plane. Certain adjacent cracks slightly misoriented with respect to one another were observed to have joined up to form a larger crack. These observations are discussed in terms of the mechanical properties and fracture behavior. (auth)

9869 INHIBITION OF CARBON DEPOSITION ON IRON AND STEEL SURFACES. Karcher, W.; Glaude, P. (Centre Commun de Recherches, Petten, Netherlands). Carbon; 9: No. 5, 617-25(Oct 1971).

Experiments were carried out on the feasibility of inhibiting the deposition of C which takes place by catalytic decomposition of CO on Fe and steel surfaces. Two distinct classes of inhibitors were investigated: compounds exerting an irreversible effect, such as SO_2 and various silanes, and inhibitors (H_2O, N_2O, NH_3, and CO_2) which are effective only if they are continuously added to the reaction mixture. It was found that, with the exception of CO_2, all the inhibitors suppress the deposition of C on Fe and steel surfaces completely if they are present in the reaction mixture in argon in a sufficient concentration. The inhibition effect decreases in the order SO_2 > silane > H_2O > N_2O > NH_3 > CO_2. Measurements of the retarding influence of H_2O as a function of H_2/H_2O ratio indicate that, in High Temperature Gas-Cooled Reactors where CO and H_2 are present in the He coolant in low and approximately equal concentrations, the deposition of C can be prevented on heat exchanger surfaces during normal operation if the H_2/H_2O ratio is maintained between 15 and 20. High CO partial pressures and H_2/H_2O ratios may be tolerated temporarily if a silane inhibitor is added in small doses to the He coolant. (auth)

9870 VAPORIZATION AND SURFACE IONIZATION OF LaC_2, CeC_2, PrC_2, NdC_2, ThC_2, AND UC_2. Sasaki, Noriaki; Kubo, Kenji; Asano, Mitsuru (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 614-21(Nov 1971).

The Langmuir vaporization and the surface ionization of LaC_2, CeC_2, PrC_2, NdC_2, ThC_2, and UC_2 from a heated graphite filament were studied mass spectrometrically. It was found that there were present small amounts of neutral and ionic metal dicarbide molecules in addition to neutral and ionic metal atoms in the LaC_2, CeC_2, PrC_2, ThC_2, and UC_2–C systems with the exception of NdC_2–C, where neither neutral nor ionic metal dicarbide molecules were observed. The reason for this exceptional behavior of the NdC_2–C system is explained by the very small vaporization coefficients, as estimated from the measurements of neutral MC_2/M ratios and ionic MC_2/M ratios. From the measurements of the heats of vaporization, it was surmised that the ionization potential of Th measured by the surface ionization comparison technique might be too high. (auth)

9871 SELF-DIFFUSION OF CARBON AND METAL ATOMS IN ZIRCONIUM AND NIOBIUM CARBIDES. Andrievskii, R. A.; Khromov, Yu. F.; Alekseeva, I. S. Fiz. Metal. Metalloved.; 32: No. 3, 664-7(Sep 1971). (In Russian).

An effort was made to refine the measurements of self-diffusion in Zr and Nb carbides previously made by the same authors. For five ZrC and four NbC samples, the accurate chemical formula by analysis, the porosity, average grain dimensions, and self-diffusion parameters are tabulated. The coefficients of self-diffusion are plotted as a function of the reciprocal temperature, verifying the linearity of the relationships. (K.S.W.)

9872 INFLUENCE OF OXYGEN AND GAMMA RADIATION ON THE ELASTICITY MODULUS AND INTERNAL FRICTION OF ZIRCONIUM IODIDE. Fedorov, G. B.; Kussil, A. E.; Fetisov, G. V. (Moscow Engineering Physics Inst.). Fiz. Metal. Metalloved.; 32: No. 3, 621-5(Sep 1971). (In Russian).

The effects of oxygen alloying and of γ-radiation on the internal friction of ZrI_4 were studied. The existence of stable complexes of oxygen-vacancy in Zr is possible even after high temperature annealing. Similar complexes possess activation energies close to that of self-diffusion, suggesting a connection between oxygen vacancies and the anomalous diffusion properties of α-Zr. Alloying of ZrI_4 with 0.6% oxygen raised the modulus of elasticity over the range 20 to 600°C. (tr-auth)

9873 ROLE OF PLASTIC DEFORMATION IN THE THERMAL DESTRUCTION OF REFRACTORIES. Dauknis, V. I.; Kazakyavichyus, K. A.; Yurenas, V. L. (Inst. of Physical-Technical Problems of Energy, Vilnyus, USSR). Refractories (USSR) (Engl. Transl.); 12: No. 5-6, 376-81(May-Jun 1971).

Translated from Ogneupory; 12: No. 6, 31-5(Jun 1971).

Plastic deformations developing during the high temperature operation of refractories reduces the temperature stresses and thus increases the thermal-shock resistance of the material. This was also confirmed both by calculations and by experiment. At relatively low temperatures (in the first temperature range) for which plastic deformations were practically absent, the thermal-shock resistance of the refractories was relatively low. In the second and third temperature ranges the thermal-shock resistance appreciably increased, since the temperature stresses in these ranges were markedly relaxed. Changes in the quantity of impurities and the porosity only slightly affected the nature of the temperature dependence of thermal-shock resistance. (auth)

9874 CORUNDUM REFRACTORY OF INCREASED THERMAL-SHOCK RESISTANCE. Gaodu, A. N.; Shapiro, Ya. Z.; Shaptala, V. I. (Ukrainian Research Inst. of Refractories, Kiev). Refractories (USSR) (Engl. Transl.); 12: No. 5-6, 389-92(May-Jun 1971).

Translated from Ogneupory; 12: No. 6, 42-5(Jun 1971).

Studies were made on thermal conditions for preparing corundum chamotte and effects of grain-size distribution on the thermal-shock resistance, density, and strength of the products. The results showed that an increase in the content of densely sintered chamotte in fractions of 1 to 0.06 mm increased the porosity and strength of the products and caused a marked reduction in the thermal-shock resistance. Additions of kaolin and chromite tended to increase the thermal-shock resistance when they were used with corundum chamotte fired at 1300 and 1600°C, but hardly affected the thermal-shock resistance with the use of these additives and densely sintered chamotte fired at 1750°C. An addition of ZrO_2 in the bond was more effective with the use of chamotte obtained at 1600°C. The specimens fired at 1600°C had a higher thermal-shock resistance (15 to 24 heat cycles) than those fired at 1750°C (6 to 11 heat cycles). It was also found that the production of corundum refractories with a granular structure should be varied in accordance with the requirements placed by the working conditions on the main working properties of the refractories. (P.C.H.)

9875 CERAMICS BASED ON ZIRCONIUM DIOXIDE STABILIZED WITH YTTRIUM CONCENTRATE. Kuznetsov, A. K.; Krasil'nikov, M. D.; Keler, E. K. (Inst. of Silicate Chemistry, Moscow). Refractories (USSR) (Engl. Transl.); 12: No. 5-6, 393-5(May-Jun 1971).

Translated from Ogneupory; 12: No. 6, 45-8(Jun 1971).

Zirconium dioxide with an addition of 15% by weight of yttrium concentrate when fired at 1550°C, and held for 5 hr, formed a solid solution of the fluorite cubic modification type. This solid

solution did not decompose when held for long periods in the range 1100 to 1400°C, possessed excellent resistance at temperatures of about 2100°C, and in this regard was equivalent to zirconia–yttrium solid solution. The materials based on zirconia stabilized with yttrium concentrate had somewhat higher specific electric conductivities than zirconium–yttrium solid solutions. (auth)

9876 SOME PROPERTIES OF ELECTROFUSED ZIRCON–MULLITE REFRACTORY. Meloyan, S. S.; Kocharyan, G. B.; Aroyan, N. O. Refractories (USSR) (Engl. Transl.); 12: No. 5-6, 403-4(May-Jun 1971).

Translated from Ogneupory; 12: No. 6, 53-5(Jun 1971).

The properties of electrofused zircon–mullite refractory obtained from Tumanyan stone-like clay, processed alumina, and zircon concentrates were compared with those of fireclay products, which at present are used for lining glass tanks and some heating units in the iron and steel industry. The results showed that in terms of density, strength at normal and high temperatures, resistance to abrasion, and slagging reagents, fused-cast–mullite refractories based on Tumanyan stone-like clay are better than fireclay, and may be recommended for use in glass furnaces and certain metallurgical furnaces. (P.C.H.)

9877 CONTACT REACTION OF METALLIC TITANIUM WITH OXIDE REFRACTORY MATERIALS. Gopienko, V. G. (All-Union Aluminum-Magnesium Inst., Leningrad). Refractories (USSR) (Engl. Transl.); 12: No. 5-6, 405-7(May-Jun 1971).

Translated from Ogneupory; 12: No. 6, 55-8(Jun 1971).

Thermodynamic calculations were made on the possible reactions of metallic Ti with the surface of oxide refractory materials. The transverse sections of Ti coatings on the refractories were also studied. Starting from the thermodynamic calculations in the range 298 to 1200°K, the probability of contact reaction exists for the oxides SiO_2, Fe_2O_3, Cr_2O_3, and TiO_2; for the oxides Al_2O_3, ZrO_2, MgO, CaO, the probability of reactions with metallic Ti is low. Reactions are most possible with the formation of TiO. The results of metallographic studies on thin slides of Ti coatings formed on the surface of certain refractories are discussed. (P.C.H.)

9878 DRY FRICTION AND WEAR OF ALLOYS OF DIBORIDE–NITRIDE SYSTEMS AT NORMAL TEMPERATURES. Medvedeva, O. A.; Sin'kov, V. A. (Inst. of Materials Science, Kiev). Sov. Power Met. Metal Ceram. (Engl. Transl.); 10: No. 7, 561-4(Jul 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 7, 63-7(Jul 1971).

A study was made on the room temperature dry friction and wear of alloys of the systems ZrB_2–ZrN and HfB_2–HfN in air. It was found that all the materials investigated possess high wear resistance. The lowest values of coefficient of friction (0.3–0.4) and increased wear resistance at a sliding speed of 1 m/sec were exhibited by composites based on hafnium diboride and those containing 40 to 70 mole % zirconium nitride. (auth)

9879 HEAT OF COMBUSTION OF THE ACTINIDE CARBIDES (ThC, PuC, Pu_2C_3). Lorenzelli, Robert; De Dieuleveult, Ivan; Melamed, Jeanne (CEN, Fontenay-aux-Roses, France). J. Inorg. Nucl. Chem.; 33: No. 10, 3297-3304(Oct 1971). (In French).

Heats of combustion of the carbides of actinides ThC, PuC, Pu_2C_3 were measured by means of a calorimetric bomb. The following enthalpies of formation were derived from these measurements: $ThC_{1.00}$: $\Delta H_f^{298} = (-30.2 \pm 2.5)$ kcal/mole, $PuC_{0.91}$: $\Delta H_f^{298} = (-12.0 \pm 2.0)$ kcal/mole, $PuC_{1.50}$: $\Delta H_f^{298} = (-24.4 \pm 2.7)$ kcal/mole. (auth)

9880 STRUCTURAL DAMAGE IN GRAPHITE OCCURRING DURING PORE SIZE MEASUREMENTS BY HIGH PRESSURE MERCURY. Baker, D. J.; Morris, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 9: No. 5, 687-90(Oct 1971).

By carrying out repeat measurements on the same sample it was confirmed that the internal pore structure of graphite can be permanently damaged by mercury at high pressure. The effect of the damage for the particular material studied was to increase the amount of accessible pores of size smaller than 2 μm. The corresponding pressure based on the capillary equation of 0.7 MN/m^2 (100 psi) does not necessarily mark the onset of damage, but it had certainly begun when the pressure reached 18 MN/m^2 (2600 psi) (equivalent pore size = 0.08 μm). A second effect of mercury at high pressure is to open up in a reversible manner a small volume of normally closed porosity, probably not exceeding 1% of the sample volume. (auth)

9881 HIGH TEMPERATURE ENTHALPY AND RELATED THERMODYNAMIC FUNCTION OF UO_{2+x}. Marchidan, D. I.; Ciopec, M. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 16: No. 8, 1145-54(Aug 1971).

Enthalpy data are reported for $UO_{2+0.5}$ over a temperature range from 300 to 1300°K. A drop technique was employed in conjunction with an isothermal-jacket, block-type calorimeter in order to measure the heat release which was then converted into enthalpies. Prior to these tests similar measurements were carried out on the synthetic sapphire used as a standard substance. Nonstoichiometric uranium oxide was "frozen" by sealing it in a platinum container under vacuum. From the experimental results four polynominal equations were smoothed for the enthalpy of $UO_{2.5}$. Out of these relations only one was preferred which produces the best fit. The thermodynamic function values derived for $UO_{2.5}$ are given at every 50°K from 300 to 1300°K. A comparison is made between present data and previous values. (auth)

9882 THERMAL CONDUCTIVITY OF EUROPIUM OXIDE. Kiparisov, S. S.; Kuznetsov, S. A.; Kozlov, V. G.; (and others) (Moscow Inst. of Steel and Alloys). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 6, 953(Jun 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 6, 1073(Jun 1971).

The thermal conductivity of Eu_2O_3 was measured under stationary conditions by the flat-layer method. The tabulated results show that at temperatures of 25 to 480°C, the values varied from 3.42 to 2.96. (P.C.H.)

9883 SYSTEM Sc_2O_3–ZrO_2. Volchenkova, Z. S.; Lakeeva, Z. N. (Inst. of Electrochemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 6, 956-8(Jun 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 6, 1076-7(Jun 1971).

The solubility of ZrO_2 in Sc_2O_3 in the region of compositions from 0 to 5 mole % ZrO_2 by x-ray analysis and the electric conductivity method is described. From the x-ray data, it was concluded that a solid solution of ZrO_2 in Sc_2O_3 exists. A decrease in the lattice constant corresponds to addition to Sc_2O_3 of an oxide with a smaller cationic radius. Data on the change in the p-type electronic component with the composition of the specimens confirmed the presence of an Sc_2O_3-based solid solution in the region of composition from 0 to 5 mole % ZrO_2. (P.C.H.)

9884 DIELECTRIC PROPERTIES OF SINTERED YTTRIUM OXIDE. Hyde, Garrett R. (College Park Metallurgy Research Center, Md.). J. Amer. Ceram. Soc.; 54: No. 11, 535-8(Nov 1971).

Relaxation phenomena were observed in sintered Y_2O_3 at frequencies from 10^{-3} to 10^5 Hz at 150, 200, 255, 306, and 357°C. The observed dispersion is predicted approximately by a theory requiring exponential decay of the polarization. The theory describing the larger lower-frequency relaxation should be based on interfacial mechanism with an intergranular region of higher conductivity. Electrode effects cannot be ruled out, however, on the basis of the present work. The most probable basis for the theory describing the smaller higher-frequency relaxation is defect-dipole polarization. (auth)

9885 ENTHALPY OF URANIUM–PLUTONIUM OXIDES: $(U_{.8}Pu_{.2})O_{1.97}$ FROM 2350 TO 3000 K. Leibowitz, L.; Fischer, D. F.; Chasanov, M. G. (Argonne National Lab., Ill.). J. Nucl. Mater.; 42: No. 1, 113-16(Jan 1972).

The results of measurements on the enthalpy of $(U_{0.8}Pu_{0.2})O_{1.9}$ between 2348 and 3005°K are reported. The data are presented in graphic form and are compared with values obtained previously by others. (P.C.H.)

9886 SELF-DIFFUSION OF OXYGEN IN HYPERSTOICHIOMETRIC URANIUM DIOXIDE. Contamin, P. (CEN, Grenoble, France); Bacmann, J. J.; Marin, J. F. J. Nucl. Mater.; 42: No. 1, 54-64(Jan 1972). (In French).

The self-diffusion of oxygen in hyperstoichiometric uranium dioxide UO_{2+x} ($0.006 \leq x < 0.16$) has been investigated with tracer oxygen-18, in the temperature range between 400 and 900°C. ^{18}O diffusion profiles were analyzed by two different methods: either mass spectrometry or nuclear reactions. The activation energy for self-diffusion of ^{18}O, 21 kcal · $mole^{-1}$, was independent of x ($x \geq 0.006$). The apparent diffusion coefficient was lowered when a second phase U_4O_9 was present in UO_{2+x}. No grain boundary diffusion of oxygen was evidenced. The oxygen self-diffusion coefficient in UO_{2+x} may be expressed as a function of x ($x > 0$) and temperature with a semi-empirical equation. (auth)

9887 PHASE EQUILIBRIUM STUDIES OF THE SYSTEM SCANDIUM OXIDE–ACTINIDE OXIDE (Th–Am). Keller, C.; Berndt, U.; Debbabi, M.; Engerer, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 42: No. 1, 23-31(Jan 1972). (In German).

In the systems scandium oxide–actinide oxide (Th to Am) there exists, in the region of the individual components between 1100 to 1550°C, only one fluorite phase $(Me,Sc)_{2+x}$; intermediate, ordered phases were not observed. The relatively small solubility of $ScO_{1.5}$ was significantly larger in the hypostoichiometric and hyperstoichiometric compound, and it increased with increasing temperature and a decreasing difference in ionic radii $|r^{4+}_{Me} - r^{3+}_{Sc}|$. The maximum average valence of uranium and neptunium in the oxidized fluorite phases $(U,Sc)O_{2+x}$ and $(Np,Sc)O_{2+x}$ was smaller than in the analogous systems with lanthanide oxides. The solubility of $ScO_{1.5}$ in the actinide oxides MeO_{2+x} between 1100 and 1550°C is given as are the phase-diagrams of the systems $UO_2-UO_3-ScO_{1.5}$ and $NpO-NpO_{2.1}-ScO_{1.5}$ at 1250°C. (auth)

9888 WETTING OF CERAMICS BY MOLTEN METALS. Rossington, David R. (Alfred Univ., N. Y.); Harding, Foster L. Rev. High Temp. Mater.; 1: No. 1, 9-54(Aug 1971).

A review of the theory of wetting of solids by liquids is given together with equations developed for the determination of surface free energy, contact angle, and surface tension. Experimental techniques for the investigation of these parameters by means of the sessile drop method are presented, with an account of the mathematical treatment for data processing. Some of the more significant studies in the field of ceramics and oxide materials by liquid metals are presented. Correlations between the wetting properties of ceramics and other solid state properties are discussed. (88 references) (auth)

Structure and Phase Studies

Refer also to abstract 9796.

9889 (AEC-tr-7288) ON THE EXISTENCE OF A CONTINUOUS TRANSITION BETWEEN THE FLUORITE STRUCTURE AND THE Tl_2O_3-TYPE STRUCTURE IN THE ZIRCONIUM DIOXIDE–RARE EARTH OXIDE SYSTEMS. Perez y Jorba, Monique; Queyroux, Francine; Collongues, Robert. Translated from Compt. Rend., Ser. C; 253: 670-2(1961). 4p. Dep. NTIS.

A description is given of the change in the structure of ZrO_2–rare earth oxide cubic solid solutions as a function of the rare earth oxide content. A continuous transition between the fluorite-type structure and the Tl_2O_3-type structure was observed in several $ZrO_2-M_2O_3$ systems at high temperature when the rare earth oxide content increased. The systems $ZrO_2-Gd_2O_3$, $ZrO_2-Dy_2O_3$, and $ZrO_2-Yb_2O_3$ were investigated. (P.C.H.)

9890 (ANL–7822) CHEMICAL ENGINEERING DIVISION FUELS AND MATERIALS CHEMISTRY SEMIANNUAL REPORT, JANUARY–JUNE 1971. Blackburn, P. E.; Johnson, C. E.; Battles, J. E.; Johnson, I.; Martin, A. E.; Tetenbaum, M.; Crouthamel, C. E.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Sep 1971. Contract W-31-109-eng-38. 32p. Dep. NTIS.

To aid in evaluating the performance of fast-breeder reactor fuels, high-temperature investigations are being made of the U-Pu-O-Na, U-Pu-O-Cs, U-Mo-O, and U-C-O systems, and the chemical behavior of irradiated fuels is being investigated. Mass-spectrometric and phase studies of the U-O-Na and U-Pu-O-Na systems are being directed toward determining conditions under which a reaction between oxide fuels and sodium coolant can be prevented. Mass-spectrometric studies of the U-Mo-O system are being conducted to aid in understanding the migration of fission-product molybdenum and fuel-cladding interactions that occur in irradiated oxide fuels. Phase relationships of the U-Pu-O-Cs system are being investigated to establish conditions under which fission-product cesium interacts with mixed-oxide fuel during irradiation and to obtain data useful in the development of an understanding of the irradiated fuel-cladding interactions. Activity measurements in the U-C-O system have been made by a gas-equilibration and transpiration technique to determine the effects of oxygen contamination on the performance of carbide fuels. Studies have been made of the distribution of fission products in irradiated UO_2–20 wt % PuO_2 fuels. Data are presented on the radial distribution of ^{85}Kr in vibratorily compacted fuel, and a comparison is made of the radial distribution of ^{137}Cs in vibratorily compacted and high-density pellet fuels. Results of recent work indicated that in irradiated mixed-oxide fuels the mechanism of attack of the cladding is oxidation at the grain boundaries. Microprobe examination of specimens of stainless steel cladding has shown the presence of oxygen as well as cesium and molybdenum in areas of intergranular attack. (auth)

9891 STUDIES ON THE V_2O_5–MoO_3 SYSTEM: PHASE ANALYSIS. Bielanski, A.; Dyrek, K.; Pozniczek, J.; Wenda, E. (Jagellonian Univ., Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 8, 507-12(1971).

A series of $V_2O_5-MoO_3$ catalysts were obtained by a fusion of mixtures of analytically pure oxides of different molar ratios at 700°C. X-ray analysis showed the formation of a solid solution of MoO_3 in V_2O_5 in precipitations containing up to 30 mole % MoO_3. At higher MoO_3 concentrations, an intermediate compound, probably $V_9Mo_6O_{40}$, was formed. This latter supposition was also confirmed by the results of thermal phase analysis. (auth)

9892 FORMATION OF THIN FILM SINGLE CRYSTALS OF GADOLINIUM MONOXIDE. Bist, B. M. S.; Srivastava, O. N. (Banaras Hindu Univ., India). Phys. Status Solidi (a); 7: No. 1, K9-11(16 Sep 1971).

G and O thin films were prepared by vacuum distillation of partially oxidized Gd metal powder: The powder is heated at ~800°C for 6 hr, and distillation is carried out by heating at ~1800°C in 10^{-6} torr and condensing the vapor on a grid. The thin film, ~400 Å thick, was found to have a fcc structure with $a = 5.24 \pm 0.05$ Å and a zinc sulfide-type structure. A diffraction pattern of a single-crystal region shows (111) orientation. Pulse annealing by an electron beam produces a superlattice and domains. (D.L.C.)

9893 REACTION OF ZrB_2 WITH TUNGSTEN. Avgustinik, A. I.; Ordan'yan, S. S.; Serbezova, R. Ya. (Leningrad Technological Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 686-7(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 789-91(May 1971).

The reactions of zirconium diboride with tungsten in a wide range of concentrations and temperatures were studied. The cross section ZrB_2-W in the $Zr-B-W$ system is quasibinary. The phase diagram of the ZrB_2-W system is of the eutectic type; the composition of the eutectic is 20 wt % ZrB_2 + 80 wt % W and the temperature 2250 ± 40°C. (auth)

9894 STRUCTURAL CHANGES IN RESISTANCE HEATERS BASED ON ZIRCONIUM DIOXIDE. Rutman, D. C.; Taksis, G. A.; Perepelitsin, V. A.; (and others). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 779-80(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 884-5(May 1971).

Ceramic heater elements based on ZrO_2 stabilized by CaO were investigated. It was found that after 70 to 100 hr service at high temperatures the heating element consists of prisms elongated along the longitudinal axis. Other changes such as porosity, phase composition, and crystal structure are described. (J.R.D.)

9895 ALLOYS OF THE SYSTEM Si–B–C. Kalinina, A. A.; Sokhor, M. I.; Shamrai, F. I. (All Union Scientific-Research Inst. of Abrasives and Grinding, Moscow. Inst. of Metallurgy, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 677-82(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 778-85(May 1971).

Alloys of the sector near the SiC – B cross section of the phase diagram of the system Si – B – C, prepared by single and double hot pressing with prolonged thermal annealing (homogenization) were investigated. The principal phase of these alloys is SiC with dissolved boron. The maximal solubility of boron in SiC is less than 4%. The microhardness does not exceed 3430 kg/mm². Silicon carbide crystallizes in the cubic or hexagonal (6H, 4H, 15R) modifications, depending on the synthesis conditions. The alloys contain SiC-based solid solutions along with solid solutions based on silicon and boron carbide, which form a ternary eutectic with silicon carbide. The resistivity of the alloys in the different stages of synthesis varied from 10^{-1} to 10^5 Ω·cm. (auth)

9896 REACTION OF HAFNIUM DIOXIDE WITH YTTRIUM OXIDE. Portnoi, K. I.; Romanovich, I. V.; Timofeeva, E. N. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 783-4(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 888-9(May 1971).

Reactions of HfO_2 with Y_2O_3 at 600 to 2800°C in the concentration interval from 1 to 100 mole % Y_2O_3 were studied by x-ray and thermal analysis. The results indicate the presence of a series of solid solutions in the system. The lattice constants of the solid solutions increase with Y_2O_3 content. (J.R.D.)

9897 MICROSTRUCTURE AND PROPERTIES OF COBALT–CHROMIUM–TUNGSTEN–CARBON ALLOYS. Finardi, Jorge; Pieske, Adolar; Falleiros, Ivan G. S. Metalurgia (Sao Paulo); 26: No. 154, 703-9(Sep 1970). (In Portuguese).

Cast cylindrical test pieces of Stellite-type alloys containing about 29% Cr and 0 to 18% W, with the W : C ratio being held at about 5, were studied. Bend strength decreased continuously as

C and W contents increased, except in the 2.0 to 2.5% C range. This irregularity may have been due to the presence of two types of carbides. The increasing number of needle-shaped carbides formed as W and C contents increased was responsible for the loss of bend strength. Increasing the cooling rates of the specimens by reducing their cross-section led to a refinement of structure and raised the modulus of rupture under bending. This effect was more pronounced in alloys with high W and C contents, i.e., refinement of the primary phase is more pronounced when this phase is a carbide. Hardness also increased with increasing W and C contents. The text contains 17 micrographs. (Metals Abstr.)

9898 SHAPING AND GROWTH OF TUNGSTEN OXIDE AND MOLYBDENUM OXIDE CRYSTALS DURING ANNEALING AND REDUCTION. Savin, A. V.; Smirnov, N. D.; Vodop'yanova, L. S. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 7, 568-72(Jul 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 7, 73-8(Jul 1971).

Studies were made on the changes that take place in the shape and size of tungsten oxide and molybdenum oxide crystals during heating in various gaseous atmospheres and in a vacuum and the possible mechanism by which material transport occurs during this process. During heating in a vacuum, WO_3 crystals, like the more volatile MoO_2 crystals, assumed the shape of whiskers. Material transport resulting in the formation of MoO_3 and WO_3 whiskers took place, via the gaseous phase. The formation of equiaxed crystals of WO_3 during air annealing and of WO_2 and MoO_2 during argon annealing at up to 1200°C under a pressure of 1 atm apparently required no participation of the gaseous phase. Thus, under the usual conditions encountered in practice, the volatility of WO_3, WO_2, and MoO_2 had virtually no effect on the character of formation of crystals of these oxides and of metallic particles produced from them. Different mechanisms were involved in the formation of particles of these two types. (P.C.H.)

9899 PROPERTIES OF COMPLEX TiC–WC CARBIDES IN THEIR HOMOGENEITY REGION. I. PREPARATION AND PHASE AND STRUCTURAL ANALYSES OF TiC–WC ALLOYS. Vitryanyuk, V. K.; Chaplygin, F. I.; Kostenetskaya, G. D. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 7, 547-52(Jul 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 7, 46-52(Jul 1971).

A study was made on the conditions for preparation of TiC–WC solid solutions based on titanium carbide in its homogeneity region. It was found that, at all carbon contents, alloys containing up to 50 mole % WC have a single-phase fcc structure. At higher WC concentrations, such alloys consist of a TiC_y–WC solid solution and free tungsten carbide. X-ray diffraction analysis failed to detect any solubility of TiC in WC. With increasing carbon deficiency in titanium carbide, the solubility of tungsten carbide in this compound increased, the lattice constant fell sharply, and the grain size of the solid solution grew, which may be attributed to intensified electronic exchange between the atoms of the components and an increase in the statistical weight of atoms with stable configurations. (auth)

9900 ANALYSIS OF DISLOCATION STRUCTURES IN TUNGSTEN CARBIDE BY ELECTRON MICROSCOPY. Johannesson, T.; Lehtinen, B. (Coromant Research Centre, Stockholm). Phil. Mag.; 24: No. 191, 1079-85(Nov 1971).

Tungsten carbide was studied in the transmission electron microscope. The existence of dislocations with Burgers vectors $\frac{1}{3}\langle 11\bar{2}3\rangle$ is confirmed. They are found to be superdislocations having unit dislocations of Burgers vectors $\frac{1}{6}\langle 20\bar{2}3\rangle$ and $\frac{1}{6}\langle 02\bar{2}3\rangle$. Contrast calculations support this conclusion. Dislocation networks were also observed. (auth)

9901 CHARACTERISTICS OF CHEMICAL BONDING IN RARE-EARTH CARBIDES. Kosolapova, T. Ya.; Makarenko, G. N.; Domasevich, L. T. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 5, 965-9(May 1971).

Translated from Zh. Prikl. Khim.; 44: No. 5, 953-8(May 1971).

It is concluded from data obtained in studies of the composition of products formed when rare-earth carbides are decomposed by water and from data on the physical properties of RE carbide phases that covalent-metallic bonding predominates in dicarbides, with a small degree of ionic bond character. The degree of ionic bond character is higher in sesquicarbides, with a considerable degree of metallic bonding, while monocarbides are characterized predominantly by ionic bonding. (auth)

9902 SIMPLE MODEL OF THE EFFECT OF INTERSTITIAL ATOMS ON THE INTERLAYER PROPERTIES OF A GRAPHITE CRYSTAL. Kelly, B. T. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Carbon; 9: No. 5, 627-31(Oct 1971).

A simple model of the effect of interstitial atoms on the interlayer properties of a graphite crystal is derived and compared with experimental data. The analysis yields the derivatives of the interaction energy of an interstitial and the adjacent layers. It is concluded that interstitial carbon atoms due to irradiation above room temperature do not form covalent bonds with the adjacent layers. (auth)

9903 PLASTIC DEFORMATION OF ZrB_2 SINGLE CRYSTALS. Haggerty, J. S.; Lee, D. W. (Arthur D. Little, Inc., Cambridge, Mass.). Contract AT(30-1)-3411. J. Amer. Ceram. Soc.; 54: No. 11, 572-6(Nov 1971).

The active slip planes, the Burgers vector, and the critical resolved shear stress to induce macroscopic deformation in ZrB_2 single crystals were determined. Room-temperature microhardness indentation and high-temperature uniaxial compression loadings were used to induce deformation. Slip occurred in a close-packed a direction on prismatic planes at room temperature and on the basal plane at high temperatures. The high-temperature yield stress and yield drop are discussed in terms of a Widmanstaetten-type precipitate observed in the crystals. (auth)

9904 URANIUM–PLUTONIUM–CARBON–OXYGEN SYSTEMS. THE TERNARY SYSTEMS URANIUM–CARBON–OXYGEN AND PLUTONIUM–CARBON–OXYGEN, AND THE QUATERNARY SYSTEM URANIUM–PLUTONIUM–CARBON–OXYGEN. Potter, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 42: No. 1, 1-22(Jan 1972).

Published data on the phase diagrams, equilibrium gas pressure measurements, and other thermodynamic data for the uranium–carbon–oxygen, plutonium–carbon–oxygen, and uranium–plutonium–carbon–oxygen systems have been reviewed. Much of the experimental data is consistent with the published thermodynamic data for the relevant binary systems providing a regular solution model is used to describe the monoxide-monocarbide solid solutions. For the U–C–O system, the maximum limit of substitution of oxygen in UC is equivalent to 35 mole % UO, and an interaction parameter of ~–20 kcal for the UC–UO solution is required to obtain reasonable agreement with the experimental data between 1300 and 1700°C. For the Pu–C–O system, the maximum solubility of oxygen in PuC is equivalent to ~65 mole % PuO. A regular solution for PuC–PuO with an interaction parameter of ~–2 kcal gives consistency with the experimental observations between 1000 to 1550°C. Because of the low free energy of vaporization of Pu, the Pu–C–O system possesses a region very close to a composition ~$PuC_{0.5}O_{0.5}$ where congruent vaporization occurs. (49 references). (auth)

9905 CONTRIBUTION TO THE STUDY OF THE TERNARY SYSTEM URANIUM–SILICON–BERYLLIUM. Molho, S. (CEN, Grenoble, France). J. Nucl. Mater.; 42: No. 1, 65-72(Jan 1972). (In French).

The isothermal section of 900°C of the U–Si–C equilibrium diagram was mapped, and the existence of three significant solid solutions were found. These were: a substitutional solid solution of silicon in the UBe_{13} phase extending to 4.1 at. % Si; a solution of beryllium in the $USi_{1.88}$ phase extending to 17 at. % Be; and a solution of beryllium in the U_3Si_5 phase extending to 26 at. % Be. In the last two phases, the substitution process was found to be preceded by a filling of the silicon vacancies by beryllium atoms. Furthermore, observations performed on melted alloys of various compositions allow an outline of the liquidus to be drawn. The different constituents involved in this system were subjected to an extensive x-ray diffraction study whereby an order-disorder transition taking place in the $U_3(SiBe)_5$ phase near its saturation composition could be established. (auth)

Radiation Effects

Refer also to abstracts 9687, 10292, and 10293.

9906 (GEAP-13686) IRRADIATION INDUCED SWELLING RATES OF PuO_2–UO_2 FUEL WITH STRONG RADIAL RESTRAINT. Nelson, R. C.; Baumgartner, J. A.; Perry, K. J.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Mar 1971. Contract AT(04-3)-189. 75p. Dep. NTIS.

Swelling behavior of uranium–plutonium oxide fuel as a function of burnup was determined in a series of experiments carried out at 1400, 1800, and 2220°C. Interim nondestructive measurements permitted the study of fuel growth as a function of burnup to levels

up to 320,000 MWd/Te. By a special design feature of the fuel capsules, fission gas release was also determined as a function of fuel burnup. It was found that fuel swelling represents a competition between the formation of Xe and Kr (which is linear with burnup) and the release of these gases (which is determined by the temperature history of the fuel). The rate of swelling ranged between values of $\Delta V/V$ of 0.12% per 10^{20} fissions/cc at low burnups to 0.23% at burnups of 80×10^{20} fissions/cc (320,000 MWd/Te). At high burnups, the fuel was plastic at temperatures as low as 700°C. (auth)

9907 (GULF-GA-A-10694) RESEARCH ON GRAPHITE. Annual Report, May 15, 1970–June 30, 1971. Engle, G. B.; Bokros, J. C.; Price, R. J. (Gulf General Atomic Co., San Diego, Calif.). 15 Nov 1971. Contract AT(04-3)-167. 93p. Dep. NTIS.

Nuclear graphites having a wide range of microstructures and properties and model carbon materials were irradiated in the range 1 to 20×10^{21} n/cm^2 at 500 to 1430°C. The materials were characterized prior to irradiation by measurement of physical and mechanical properties and densities, and examination of microstructure by x-ray diffraction and microscopy. Dimensional, density, structural, and property changes were measured after irradiation. Anisotropic needle-coke graphites and isotropic graphites were shown to have structural and property variations that lead to variations in their high-temperature irradiation behavior. A high original strength leads to less initial contraction and a delay in the final expansion at high fluences. Isotropic graphites in general have higher strength values than the anisotropic materials. However, high preirradiation strength was found to be more important than isotropy in inhibiting breakaway growth in highly oriented graphites at high fluences. Graphites with intermediate apparent densities, as measured by immersion in liquid, tend to show smaller density changes than those of low or high densities. However, bulk density changes do not always follow the changes of these apparent densities. When graphites are irradiated initially at 1000 to 1200°C, to an intermediate fluence and then taken to higher fluences at a temperature ~200°C lower, the dimensional change at the lower temperature appears to be influenced by the previous higher temperature irradiation in such a way that the data fall witnin the same band of data from similar samples irradiated to higher fluences at the higher temperatures. However, additional data are required at all fluences up to 10^{22} n/cm^2 to evaluate the magnitude of this effect. At 1000 to 1200°C thermal expansivity changes depend upon the graphite structure; certain needle-coke materials show an increase coinciding with volume increase at high fluences, whereas isotropic materials show a decrease. The thermal expansivity of one graphite composed of both anisotropic and isotropic structure did not change up to 2×10^{22} n/cm^2. Thermal conductivity is reduced to about 0.02 cal/cm-sec-°C after irradiation to 2×10^{22} n/cm^2. This reduction coincides with the formation of large volumes of porosity in the graphites. Degradation of thermal conductivity is dependent on temperature in the range 800 to 1430°C at low fluences, the specimens irradiated at 1430°C showing the smallest fractional changes. Cokes, which are the filler component in commercial graphites, were characterized and irradiated. Irradiation of model carbons to high fluences at high temperatures shows that for maximum stability, carbonaceous materials should be perfectly isotropic and have high strength and intermediate densities. The thermal conductivity of carbons with L_c values greater than 100 Å showed a reduction in thermal conductivity that saturated with increasing fluence. The reduction was less for higher irradiation temperatures. The thermal conductivity of carbons with smaller L_c values increased or decreased depending on irradiation conditions. (auth)

9908 (GULF-GA-A-10863) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending September 30, 1971. Engle, G. B.; Price, R. J. (Gulf General Atomic Co., San Diego, Calif.). 29 Oct 1971. Contract AT(04-3)-167. 20p. Dep. NTIS.

The results of research on graphite for the period July 1 through September 30, 1971, are reported. Postirradiation measurements were continued on specimens irradiated previously in capsule GE-H-13-18 in the range 500 to 1430°C up to fluences of 10^{22} n/cm^2. Correlations between apparent crystallite size, crystallite size distribution, isotropy, strength, thermal expansivity, and irradiation behavior are discussed along with exceptions. The results of x-ray measurements on highly oriented graphites are presented. Irradiation-induced dimensional changes are given for petroleum- and coal-derived cokes. (auth)

9909 CRACKING OF IRRADIATED BERYLLIUM OXIDE IN VARIOUS CLEAVAGE PLANES. Khudyakov, A. V. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 772-4(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 878-9(May 1971).

A method is described for establishing the probability of splitting in various crystallographic planes in beryllium oxide. The greatest probability of splitting, and correspondingly the lowest surface energy, is found in the basal planes; the next greatest effect is in the prism planes $\{10\bar{1}0\}$. The surface energy of the basal planes decreases on irradiation, in comparison with the surface energies of all other planes. (auth)

9910 AMORPHIZATION OF Si AND WO_3 BY PARTICLE IMPACT (STUDIES ON BOMBARDMENT-INDUCED DISORDER, V). Kelly, Roger; Lam, Nghi Q. (McMaster Univ., Hamilton, Ont.). Radiat. Eff.; 10: No. 4, 247-52(Sep 1971).

Estimates of the depth of bombardment-induced amorphization (R_a) are presently available for seven different ions injected into Si(Ar, As, B, Ne, P, Sb and Si) as well as for Kr injected into WO_3. These depths can be interpreted in terms of recent damage-distribution theories to yield $F_d(R_a)$, the initial displacement fraction at depth R_a. (Here the term "initial" means "present before thermal and athermal annealing".) The resulting values of $F_d(R_a)$ were found to be reasonably constant, such that, depending on which theory was used, they had an average of either 0.7 ± 0.2 or 0.4 ± 0.2 for Si and either 0.09 ± 0.03 or 0.17 ± 0.06 for WO_3. This approximate constancy is considered to be particularly significant with Si, since the data used encompassed incident masses from 11 to 122, incident energies from 10 to 280 keV, and doses from 3×10^{14} to 1×10^{16} ions/cm^2. It is concluded, in view of the constancy of $F_d(R_a)$, that the amorphization of Si and WO_3 can be self-consistently explained by homogeneous damage accumulation. An alternative category of explanation, based on the random impingement of discrete disordered regions of volume V_a, is, however, not excluded; in fact, it is argued that the constancy demonstrated here for $F_d(R_a)$ is also compatible with discrete disordered regions provided V_a is proportional to the incident energy E. (auth)

9911 IRRADIATION BEHAVIOR OF POCO GRAPHITES. Pitner, A. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Carbon; 9: No. 5, 637-44(Oct 1971).

Results are reported for irradiation testing of a high density (1.8 g/cm^3) and low density (1.5 g/cm^3) grade of Poco graphite at temperatures from 400 to 1400°C up to maximum exposures of 14×10^{21} n/cm^2. The graphites behave isotropically under irradiation and show improved dimensional stability over conventional nuclear graphites. An attempt is made to relate the unusual irradiation behavior of the material to its microstructure. (auth)

9912 EXPERIMENTAL STUDY OF RADIATION EFFECTS ON MECHANICAL PROPERTIES OF BORONATED GRAPHITE. Murakami, Toru; Kawata, Tomio; Araki, Yasusuke; Kimura, Itsuro; Shibata, Toshikazu. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 113-18(1971).

Two kinds of boronated (3.6%) graphite (sintered to 1400 and 2000°C, respectively) were irradiated in the Kyoto Univ. reactor to doses up to $\sim 3 \times 10^{19}$ nvt (thermal). The elastic constant, bending strength, and compressive strength were measured in the longitudinal and transverse directions and compared with those of pure graphite. The changes all were positive. (D.L.C.)

9913 BEHAVIOR OF CHROMITE AND HEMATITE DURING NEUTRON BOMBARDMENT. Korenevskii, V. V.; Krivokoneva, G. K.; Pergamenshchik, B. K.; Ryabeva, E. G.; Sidorenko, G. A. (All-Union Scientific-Research Inst. of Mineral Raw Materials, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 6, 921-4(Jun 1971).

Translated from Izv. Akad. Nauk SSR, Neorg. Mater.; 7: No. 6, 1040-4(Jun 1971).

X-ray and metallographic investigations were made on chromite and hematite after irradiation with a neutron flux of up to 7×10^{20} neutrons/cm^2. The results showed that hematite does not have a high resistance to radioinduced structural changes. Irradiation with a neutron flux of up to $5.3 \cdot 10^{20}$ neutrons/cm^2 increased the microhardness and was accompanied by an anisotropic expansion and distortion of the crystalline structure, together with macroscopic expansion (1.6% in linear terms) and a decrease in hydrostatic density. Expansion of such a filler in concrete may produce additional stresses in the protective structure and cause damage to individual elements. Irradiation with a neutron flux of up to $7.15 \cdot 10^{20}$ neutrons/cm^2 did not produce marked changes in the properties of chromite (reflectance, microhardness, and the x-ray and hydrostatic densities). The increase in microfissuration of the ore, and the development of lizardite (conversion to forsterite) in these fissures did not lead to appreciable expansion of chromite. The latter was resistant to radiation and may be

recommended as a filler for concretes used in high neutron fluxes. (auth)

9914 IRRADIATION BEHAVIOR OF NUCLEAR GRAPHITES AT ELEVATED TEMPERATURES. Engle, G. B. (Gulf General Atomic Co., San Diego, Calif.). Carbon; 9: No. 5, 539-54 (Oct 1971).

Anisotropic and near-isotropic graphites were irradiated at 300 to 1500°C to fluences of up to 1.5×10^{22} n/cm^2 (E > 0.18 MeV). The maximum volume contraction of the graphites ranged from 4 to 9% at 4 to 6×10^{21} n/cm^2 at 1175 to 1280°C, and the maximum expansions from 11 to 50% at 1.5×10^{22} n/cm^2. Pores, located between crystallite clusters, were identified and shown to be those eliminated by c-axis expansion during densification while intercrystallite pores formed. The rate of elimination of the pores located between crystallite clusters increased while the rate of formation of intercrystallite pores decreased with increasing temperature. During expansion new pores formed between filler particles increasing the bulk volume expansion. Dimensional and microstructural changes were correlated with the distribution of apparent crystallite sizes, a predominance of highly graphitic structure caused maximum contraction strain and higher expansion rates after turnaround. The thermal expansivity of materials, composed predominantly of anisotropic and highly graphitic structure, increased by a factor of 2, whereas that of materials predominant in isotropic structure decreases by a factor of 2. Thermal expansivity changes coincided with volume expansions. A graphite with evenly balanced volumes of isotropic and anisotropic structures showed no change in thermal expansivity with fluence. Thermal expansivity changes followed the same correlation with apparent crystallite size and distribution of crystallite sizes as did the maximum volume contraction and expansion rates. Near-isotropic graphites containing a narrow range of crystallite sizes were more stable under fast neutron irradiation at high temperatures than anisotropic materials which had a wide range of crystallite sizes. The addition of semigraphitic isotropic carbon structure to an anisotropic material improved its stability and reduced the magnitude of the increase in thermal expansivity. (auth)

9915 COATING TECHNIQUE FOR VITROCERAMIC NUCLEAR FUEL. III. INFLUENCE OF IRRADIATION ON THE SPECIFIC VOLUME AND VISCOSITY OF ALUMINUM SILICATE GLAZES. Maxim, I. V.; Apostol, D. (State Committee for Nuclear Energy, Bucharest). J. Nucl. Mater.; 42: No. 1, 49-53(Jan 1972).

The radioinduced changes of specific volume and viscosity of alumino-silicates glazes, considered as coating materials for the vitroceramic nuclear fuel elements, were studied. The density of glass spheres having the same composition as the coating was measured before and after irradiation. The radioinduced density increase of 0.1% disappeared during a thermal treatment at 350°C. A method was developed for determining the viscosity variation of the coating as a function of temperature and irradiation dose. A coating fluidization equivalent to that caused by a temperature rise from the test-temperature of 60 to 180°C in the absence of radiation was noted for a neutron irradiation in a total flux of 2.6×10^{18} n/cm^2 at 60°C. (auth)

9916 STUDIES OF FUEL-CLAD MECHANICAL INTERACTION AND THE RESULTING INTERACTION FAILURE MECHANISM. Rolstad, E.; Knudsen, K. D. (Institutt for Atomenergi, Halden, Norway). Nucl. Technol.; 13: No. 2, 168-76(Feb 1972).

Fuel performance studies at the Halden reactor have given valuable information on how various design parameters affect the mechanical interaction between fuel and cladding. The study results have also indicated how the interaction is dependent on burnup and the power history of the fuel rod. This information was obtained by means of differential transformer-type detectors, measuring the changes in length and diameter of fuel rods while operating at power in the reactor. Based on this experience, a graphic model is proposed for the prediction of interaction as a function of power history and burnup. This concept, referred to as "isogap curves," demonstrates the importance of avoiding an increase in power at high burnup and could be useful in planning reactor operations with respect to fuel management schemes such as power changes, control rod movement, fuel shuffling, and loading. (auth)

9917 RELATION BETWEEN ELECTRICAL RESISTIVITY AND THERMAL CONDUCTIVITY OF REACTOR GRADE GRAPHITE IRRADIATED WITH NEUTRONS AT 300°C TO 400°C. Matsuo, H. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 42: No. 1, 105-7(Jan 1972).

The thermal conductivity and electric conductivity of artificial graphite were measured at room temperature after irradiation by the Kohlrausch and the potential-drop method, respectively. The irradiation temperature was from 308 to 400°C, and the thermal neutron dose was up to 22.2×10^{20} nvt. The results showed that when the electric conductivity was low, the thermal conductivity was nearly proportional to the electric conductivity. At high electric conductivities, however, this did not hold. The rate of increase in thermal conductivity with irradiation was larger than that in electric conductivity. This indicates that the saturation in electric conductivity occurs earlier than in thermal conductivity. It was concluded that with this relation and the results obtained, it is possible to estimate the total stored energy in power reactors from the measured electric conductivity. (P.C.H.)

9918 EFFECT OF IRRADIATION ON CREEP OF UO_2–PuO_2. Perrin, J. S. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. J. Nucl. Mater.; 42: No. 1, 101-4 (Jan 1972).

In-pile creep tests were made on UO_2–PuO_2 fuels. The creep curves obtained were similar to those obtained previously for UO_2. The results indicate that the in-pile creep rate enhancement is linearly dependent on fission rate. The in-pile creep rate curves for UO_2–PuO_2 became less temperature dependent at lower temperatures. The creep rate enhancement was approximately by a factor of 30, a substantial enhancement. Two separate mechanisms of in-pile creep rate enhancement in UO_2–PuO_2 are discussed. (P.C.H.)

9919 IMPURITY EFFECTS ON THE SWELLING OF IRRADIATED ALUMINUM OXIDE. Skarupa, R. A.; Backus, C. E. (Arizona State Univ., Tempe). Nucl. Technol.; 13: No. 2, 225-6(Feb 1972).

The role of impurity content in the irradiation of alumina was investigated. The extra helium production from the impurities contributes only 2% or less of the helium production from pure alumina. It is concluded that the lower swelling that is indicative of higher purity alumina is probably due to its smaller grain size rather than a mechanism associated with the impurities per se. (auth)

9920 INSTRUMENTED CAPSULE FOR MEASURING FISSION-INDUCED CREEP OF OXIDE FUELS. Solomon, A. A.; Gebner, R. H. (Argonne National Lab., Ill.). Nucl. Technol.; 13: No. 2, 177-84(Feb 1972).

The design, testing, and operation of an instrumented capsule used to study fission-induced creep of stoichiometric enriched UO_2 helices are described. Preliminary data are reported for a specimen of 1.82% ^{235}U enrichment that was irradiated in the General Electric Test Reactor. A large primary creep component was observed under a load of 211 g (equivalent to an outer fiber shear stress of 2890 psi) at a fission rate of 2.6×10^{12} fissions/cc-sec and a maximum specimen temperature of 110°C. Extrapolation of the strain-time creep data yielded a steady-state shear strain rate of $\sim 6 \times 10^{-6}$ hr^{-1} at the outer fibers. An elastic strain was also observed when the specimen was unloaded and subsequently irradiated. (auth)

Plastics and Other Materials

Refer also to abstracts 8890, 9079, 9238, 9294, 9689, 9697, 9762, and 10346.

9921 (IAE–2007) HYDRODYNAMICS OF FISSILE MATERIALS. 1. ACOUSTIC OSCILLATIONS IN THE CASE OF CONSTANT NEUTRON FLUX. Novikov, V. M. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 19p. (In Russian). INIS.

Simple criteria are offered which make it possible to judge the effects of neutron fluxes on the hydrodynamics of fission gases (fluidity). The dispersion of acoustic vibrations during a constant neutron flux was investigated with respect to various mechanisms of thermal conductivity. (tr-auth)

9922 (RFP–1725) EVALUATION OF FIBERGLAS FOR USE IN CUSHIONING PLUTONIUM PARTS. Lombardi, Ernest F.; Donovan, Robert I. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 24 Nov 1971. Contract AT(29-1)-1106. 7p. Dep. NTIS.

Fiberglas cloth pads are used as protective cushions for plutonium parts in the fabrication lines. This material, because of its superior thermal and radiation stability, replaced chamois which had been used for this purpose for a number of years. Prior to implementing this materials change, a variety of experiments were performed with Fiberglas to evaluate the material for plutonium use. The results of this investigative program are presented and discussed. (auth)

9923 STRUCTURAL PROBLEMS OF PRESTRESSED CONCRETE PRESSURE VESSELS FOR REACTORS. Inomata, Shunji (Japan Bridge and Structure Inst., Inc., Tokyo). Konkurito Janaru; 9: No. 1, 63-9(Jan 1971). (In Japanese).

With the rapid development of nuclear power generation, the demand for prestressed concrete pressure vessels (PCPV) is increasing. Structural studies on PCPV are described. As PCPVs undergo multi-axial loads differing from other structures, behavior of concrete under the multiaxial stresses at high temperature must be investigated in order to determine allowable stresses. Various failure criteria for the concrete under triaxial stresses are explained. An experimental study on creep of concrete at high temperature under the multi-axial stresses, which was made by Copalakrisknan and others, is also discussed. As a failure condition for structural designing, stresses under critical deformation by which vessels are cracked are considered. It was concluded that it is necessary for development of PCPVs to improve technical knowledge and to apply higher strength concrete. (Japan)

9924 DOSE RATE EFFECTS IN ELECTRON BEAM CURED COATINGS. Nordstrom, J. D. (Ford Motor Co., Dearborn, Mich.). pp 605-18 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

The properties of films produced by electron beam radiation of unsaturated polymer in unsaturated monomer solutions are used to determine the dose rate sensitivity of several types of coating systems. The role of polymer structure and molecular weight, monomer type, and the kind of unsaturation is investigated. Polymers investigated include polyesters with internal and pendant acrylate and methacrylate unsaturation and acrylic copolymers with pendant acrylate and methacrylate unsaturation. (auth)

9925 ELECTROCURE PROCESSING APPLIED TO PLASTIC AUTOMOTIVE PARTS. Turner, Allen H. (Ford Motor Co., Dearborn, Mich.). pp 619-28 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

Ford Motor Company is about to launch a radiation curing line which will process painted plastic parts for the interior of 1971 Mercurys, Cougars, and Fords. The line will be located at a plastics plant in Saline, Michigan. Special electron-sensitive paints will be used with electrons of energies up to 300 keV. The impingement of these electrons on the coatings will cause instantaneous polymerization and the end result will be a painted part with a superior coating possessed of excellent adhesion. Features of the proposed facility and various items of equipment are discussed. (auth)

9926 STUDY OF ATMOSPHERES FOR USE IN THE IRRADIATION PROCESSING OF COATINGS. Huemmer, Thomas F.; Ungurait, James R. (O'Brien Corp., South Bend, Ind.). pp 629-54 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

The effects of cure environment on film properties for an electron beam-cured urethane–acrylic prepolymer coating, were studied. The inert atmospheres investigated were carbon dioxide, nitrogen, helium, and mixtures thereof with oxygen. Some film properties were shown to be a function of the inert atmosphere employed when that atmosphere contained 1% oxygen or greater, and in these cases the order of activity was $He > N_2 > CO_2$. Parameters affected were gel content of the coating, postcure activity of the film, and surface cure; parameters unaffected were chemical composition and processing losses (2%). The effect of dose and dose rate on films cured in an inert atmosphere containing greater than 1% oxygen became more pronounced at increasing oxygen concentrations. For atmospheres essentially oxygen free, the dose to tack-free cure was established at 1 MRad, and maximum gel content of the film was the 2-MRad total absorbed dose level. The inhibited surface layer of films cured in atmospheres containing oxygen appeared to be low-molecular-weight species, and no unconverted monomer was indicated. (auth)

9927 ADHESIVE BONDING. Colloquium on Adhesive Bonding, Valduc, France, 17 April 1969. Bordes Pages, H.; Amalric, C.; Fidelle, J. P.; Rapin, M. (eds.). Bruyeres-le-Chatel, France; Commissariat a l'Energie Atomique (1970). 289p. (In French). (CONF-690458).

A total of 17 papers were presented. A separate abstract was prepared for each of three. (France)

For abstracts of individual papers see: 9697, 9928, and 9929.

9928 BEHAVIOR UNDER α AND γ RADIATIONS OF METAL ADHESIVE BONDS MADE WITH MODIFIED EPOXIDE RESINS. Bordes Pages, H.; Fidelle, J. P.; Roux, C.; Rapin, M. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). pp 80-96 of Adhesive Bonding. Bordes Pages, H. (ed.). Bruyeres-le-Chatel, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on adhesive bonding; Valduc, France (17 Apr 1969).

The effects of α and γ radiation on adhesive bonds made with modified epoxide resins were compared. For a given dose absorbed, the radiation effect differed according to the type of adhesive used. The main factor seemed to be the quantity of energy supplied by the radiation and not the manner in which it was given up. The surface preparations of the materials to be assembled played a very important part in this study. (France)

9929 RADIOCHEMICAL ADHESIVE BONDING PROCESS. Bex, G.; Baquey, C. (Centre d'Etudes Scientifiques et Techniques d'Aquitaine, Le Barp, France). pp 267-86 of Adhesive Bonding. /Bordes Pages, H. (ed.). Bruyeres-le-Chatel, France; Commissariat a l'Energie Atomique (1970). (In French).

From Conference on adhesive bonding; Valduc, France (17 Apr 1969).

A simple modification of epoxide resins was performed, which allows their hardening under irradiation. After such a modification these resins may be used as adhesives in the same cases as before, the hardening process only being different; this is an advantage when quick hardening is required and it is not possible to use high temperatures. Some results concerning the properties of the bondings made with these adhesives are reported. (France)

9930 COOLANT AND MATERIALS FOR REACTORS: BOILING WATER REACTORS. Masuda, Y. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 17: No. 3, 21-6(Mar 1971). (In Japanese).

As a material which satisfies many conditions required for reactor coolants, water is employed. Water has excellent thermal properties, is relatively safe, is not subject to induced radiation, and is economically competitive. However, the boiling phenomenon, one of demerits of water, keeps plant theoretical thermal efficiency under 30%. In reactors, problems are coolant purity control and material corrosion. The purity is controlled by electric conductivity, and impurities are determined by sampling methods. During construction of reactors, the entry of foreign materials into the reactor vessels must be prevented. When selecting the reactor materials, neutron absorption cross sections, induced radiation, and effects of neutron irradiation on the materials must be considered. 18-8 stainless steel is a good reactor material, but it is susceptible to local corrosion. This corrosion tendency is inhibited by reducing carbon to the minimum amount that strength permits, also impurities are eliminated as far as possible and the steel is always kept clean. This steel has high ductility and impact strength and no low-temperature embrittlement, however, it has large permanent deformation at high temperature. This deformation is overcome by work hardening. Many special alloys are employed as other reactor materials. (Japan)

9931 STUDYING THE CORROSION OF POLYMER MASSES BY THE BETA RADIATION BACKSCATTERING METHOD. Herdlicka, A. Rev. Coroz.; 1: No. 3, 159-64(Jul-Sep 1971). (In Rumanian).

The aim of the work was to find a nondestructive method for determining the occurrence and development of a corroded layer on a charged polymer test piece. It has been found that the method most suitable to the purpose and the conditions required is the β backscatter method. Aspects of β disintegration, the interaction of β particles and matter, and β backscatter phenomenon, and its application in the field of anticorrosive protection materials are discussed. The radioactive source and the necessary activity, the experimental layout, and working technology are also discussed. (auth)

9932 CONCRETE FOR THE CONSTRUCTION OF NUCLEAR POWER PLANTS. Manns, W. Beton, Herstellung, Verwend.; No. 1, 21-4(1971). (In German).

A survey of the state of knowledge and of recent research results on concrete properties for employment in reactors was given at the seminar of the American Concrete Institute (ACI) on Concrete for Nuclear Reactors held at Berlin, October 5 to 9, 1970. The presentations of the Session 2 on raw density of con-

crete, its water content, and its strength and deformation behavior are discussed in detail. (INIS)

9933 CRYSTAL STRUCTURE OF $UF_4 \cdot 2.5H_2O$. Borisov, S. V.; Zadneprovskii, G. M. At. Energ. (USSR); 31: No. 1, 63-5(Jul 1971). (In Russian).

The fundamental Patterson peaks were determined for UF_4 $2.5H_2O$, a Patterson map was drawn, and the crystal structure was interpreted giving the parameters of the elemental cell at 20° and −190°C. At 20°C, a, b, and c = 12.7568, 11.140, and 7.060, respectively. (K.S.W.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

9934 RUBIDIUM–STRONTIUM STUDIES ON BLACK HYPERSTHENE CHONDRITES: EFFECTS OF SHOCK AND REHEATING. Gopalan, K. (Univ. of California, Los Angeles); Wetherill, G. W. J. Geophys. Res.; 76: No. 35, 8484-92(10 Dec 1971).

Whole-rock Rb–Sr data were measured for 15 hypersthene chondrites, including 10 black chondrites. The latter appeared to have been the most heavily shocked and reheated. Several density fractions for two of the black chondrites, Orvinio and Farmington, were separated, and Rb–Sr analyses were performed. Whole-rock data for observed black hypersthene falls conformed (within experimental error) to the 4.5 to 4.6×10^9-year isochron defined by other chondrites. Although black "finds" plotted uniformly to the left of the isochron, this behavior was also shown by unshocked finds. Therefore the total-rock data did not reveal any significant shock or reheating effects. The density separates, particularly those of Orvinio, departed significantly from the 4.5-b.y. isochron. Although their $^{87}Rb/^{86}Sr$ ratios varied from 0.5 to 1.1, their $^{87}Sr/^{86}Sr$ ratios were the same as that of the total meteorite to within 0.002. This similarity resulted in a nearly horizontal distribution of points on a Sr evolution diagram. To a lesser extent, data from Farmington also showed the same effect. It was concluded that this behavior is due to partial homogenization of the Sr isotopes within these two meteorites very recently in their history. The scatter in the data precluded any precise determination of the time of the event. (auth)

9935 HIGH-ANGULAR-RESOLUTION ASTROPHYSICAL OBSERVATIONS FROM SPACE. De Jager, C. (Astronomical Inst., Utrecht). Earth Extraterr. Sci.; 1: No. 8, 243-50(Nov 1971).

The symposium held at Seattle in June 1971 was convened to review and compare present-day possibilities of high-angular resolution observations of the celestial bodies, from the ground, from balloons, and from space; and to have a preview of future projects, both the agreed ones and those still in the planning stage. (W.D.M.)

9936 XENON RECORD OF EXTINCT RADIOACTIVITIES IN THE EARTH. Boulos, Mervet S.; Manuel, Oliver K. (Univ. of Missouri, Rolla). Science; 174: No. 4016, 1334-6(24 Dec 1971).

Analyses of xenon from well gas rich in carbon dioxide reveal a large excess of radiogenic xenon-129 from the decay of extinct iodine-129. Smaller excesses observed in the heavy xenon isotopes are from fission. These results place narrow limits on any age difference between the Earth and the oldest meteorites. The occurrence of excess radiogenic xenon-129 in well gas also suggests that any quantitative degassing of existing solid materials to form the atmosphere must have been limited to a very early period of the Earth's history, approximately the first 10^8 years. Alternatively, this observation is consistent with a model of the Earth's continuous, but still incomplete, degassing since its time of formation. (auth)

9937 ISOTOPIC COMPOSITION OF TRAPPED HELIUM AND NEON IN CARBONACEOUS CHONDRITES. Srinivasan, B.; Manuel, O. K. (Univ. of Missouri, Rolla). Earth Planet. Sci. Lett.; 12: No. 3, 282-6(Nov 1971).

The covariance observed in the isotopic composition of primordial He, Ne, and Ar in carbonaceous chondrites can be explained on the basis of simple mass-dependent fractionation. (auth)

9938 Xe AND Kr ANALYSES OF SILICATE INCLUSIONS FROM IRON METEORITES. Bogard, D. D.; Huneke, J. C.; Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta; 35: No. 12, 1231-54 (Dec 1971).

The Xe and Kr contents of silicate inclusions from the iron meteorites Copiapo, Four Corners, Linwood, Pine River, Weekeroo Station, and Woodbine (^{132}Xe = 3 to 40, ^{84}Kr = 5 to 100×10^9 atoms/g; $^{84}Kr/^{132}Xe$ = 2) are comparable to chondritic values. The isotopic compositions show trapped gas of both chondritic composition (dominant in Pine River) and atmospheric composition (dominant in Linwood). Large spallation effects ($^{84}Kr_{sp}$ = 4×10^9, $^{126}Xe_{sp}$ = 2×10^8 atoms/g) occur in Weekeroo Station and Four Corners. The spallation Xe and Kr spectra in Weekeroo differ from those reported for stone meteorites. A re-analysis of literature data shows that systematic variations also exist among stone meteorite spallation spectra which can be qualitatively understood in terms of target element abundance and shielding variations. Very large neutron capture effects on Br and I occur in several meteorites ($^{80}Kr/^{83}Kr/^{86}Kr$ = $100/2/3 \times 10^{10}$ atoms/g in Linwood). The $(^{80}Kr/^{82}Kr)_n \cong 2.8$ ratios from neutron capture on Br for Linwood and Copiapo are distinct from that found in stone meteorites. All samples have pronounced ^{129}Xe excesses (3 to 50×10^9 atoms/g) which apparently indicate differences in formation times from chondrites of less than about 10^8 yr; however, the presence of trapped ^{132}Xe in silicates which were enclosed in molten Fe–Ni and cooled slowly prove that they were not entirely outgassed; thus, some of the ^{129}Xe excess may also be trapped. No discernible fission Xe was observed. (auth)

9939 PRODUCTION RATE OF ^{26}Al FROM TARGET ELEMENTS IN THE BRUDERHEIM CHONDRITE. Cressy, Philip J. Jr. (Goddard Space Flight Center, Greenbelt, Md.). Geochim. Cosmochim. Acta; 35: No. 12, 1283-96(Dec 1971).

An 840-g specimen of the Bruderheim chondrite was subjected to magnetic and heavy-liquid mineral separation procedures, resulting in a number of chemically distinct samples. These samples were analyzed for cosmogenic ^{26}Al by nondestructive gamma–gamma coincidence counting. The observed ^{26}Al specific activities were correlated with the chemical composition of potential target elements by a weighted least-squares fitting technique. The calculated ^{26}Al production rates, in dpm per kilogram of target element, are: Al, 1130 ± 190; Si, 245 ± 31; S, 133 ± 11; Mg, 28 ± 30. Production rates from Ca and Ni + Fe were estimated to be 24 and 2.2 dpm/kg, respectively, from spallation systematics. Most meteorite classes show a distribution of $(^{26}Al)_{obs}/(^{26}Al)_{calc}$, primarily between 0.80 and 1.10 (excluding short-exposure-age effects). The only exception is the eucrites. The five eucrites with the highest relative ^{26}Al activities have only 0.77 ± 0.03 of their respective calculated activities. Two Apollo 12 samples, from mean depths of 15 to 20 cm, have approximately 0.78 of the ^{26}Al activities calculated for their chemical compositions. A depletion in ^{26}Al in lunar samples shielded from solar radiation is in accord with a reduced cosmic-ray flux near the Earth's orbit, relative to that experience by most meteorites. The ^{26}Al depletion in the eucrites suggests that they spent a greater proportion of their orbital periods near 1 AU than have most meteorites. The similarity in relative ^{26}Al contents of the lunar samples and the eucrites may not be a coincidence. (auth)

Stars

Refer also to abstracts 9069, 10186, 10600, and 11044.

9940 STELLAR EVOLUTION AND VARIABLE STARS. Penny, A. J.; Powell, A. L. T. (Royal Greenwich Observatory, Hailsham, Eng.). Earth Extraterr. Sci.; 1: No. 8, 229-41(Nov 1971).

Summaries of the lectures given at the NATO Advanced Study Institute on Stellar Evolution and Variable Stars held at Ofir, Portugal in 1970 are given. (auth)

9941 POPULATION OF HELIUM TRIPLET STATES IN GASEOUS NEBULAE. Drake, G. W. F. (Univ. of Windsor, Ont.); Robbins, R. R. Astrophys. J.; 171: No. 1, 55-61(1 Jan 1972).

Several authors have found that in planetary nebulae the population of helium atoms in the metastable 1s2s ^3S state calculated by balancing the theoretical rates of formation and destruction is one or two orders of magnitude greater than that deduced from measured intensity ratios. The problem was reexamined, using updated atomic data and including additional triplet-depopulation mechanisms. Out of 11 objects studied, nine showed reasonable agreement between the two methods of deriving the triplet populations. It was found that in some cases depopulation of the $2\ ^3S$ state via the $2\ ^3P_1 - 1\ ^1S_0$ transition may be significant. The remaining discrepancies are no longer sufficient to require extinction of 10,830 Å photons upon dust grains, as has previously been suggested. A comparison of the present results with radiative-transfer calculations suggests that the data may be interpreted in terms of a "space filling" factor describing the degree of nebular condensation. (auth)

9942 UNUSUAL ABSORPTION FEATURE IN THE FAR-ULTRAVIOLET SPECTRUM OF EARLY-TYPE SUPERGIANTS. Underhill, A. B.; Leckrone, D. S.; West, D. K. (Goddard Space

Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 1, 63-70(1 Jan 1972).

The OAO-II satellite was used to obtain far-ultraviolet scans of six early-type supergiants. The data revealed the presence of a distinct, broad absorption feature centered near 1720 Å. This feature is unique in that it remains essentially constant in strength, breadth, and central position over the spectral-type range B0 I to A2 I. The feature also appears in the spectrum of the B-type shell star ζ Tau, with a strength comparable to that observed for the supergiants. It appears weakly, or not at all, in the B and A main-sequence spectra examined. The presence of the feature in spectra of supergiants and a shell star supports the hypothesis that it is an extended-envelope phenomenon. The hypothesis that the feature is due to a fortuitous blend of intrinsically strong lines arising primarily from the ground configurations of abundant metallic ions is considered. Its remarkable constancy with spectral type may make the feature a useful indicator of early-type supergiants and shell stars in future programs involving narrow-band ultraviolet photometric observations of faint stars. (auth)

9943 LITHIUM-ISOTOPE RATIO IN F AND G FIELD STARS. Cohen, Judith Gamora (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 171: No. 1, 71-7(1 Jan 1972).

A Fabry–Perot interferometer was used to obtain high-resolution profiles of the resonance line of Li I and λ6717.69 of Ca I in 14 bright F, G, and early K field stars. The observational data were fitted by computed theoretical line profiles to determine the rotational velocity, Li abundance, and Li isotope ratio for each star. The $^6Li/^7Li$ ratio was 0.1 or less in all the program stars. (auth)

9944 ABUNDANCE ANALYSIS OF THE PHOTOMETRIC STANDARD 29 PISCIUM. Klinglesmith III, Daniel A. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 1, 79-88(1 Jan 1972).

A fine analysis of the photometric standard star 29 Psc was performed by using flux-constant hydrogen-line-blanketed model atmospheres. The observable quantities — Balmer and Paschen slopes, Balmer discontinuity, and H and He I lines — were used to determine the final model parameters: T_{eff} = 15,150°K, log g = 4.08 and N(He)/N(H) = 0.027. Lines from 14 elements besides H and He were identified; five elements (C, Mg, Si, Ti, and Fe) had a sufficient number of unblended lines with known gf-values to attempt an abundance determination. (auth)

9945 p-PROCESS IN EXPLOSIVE NUCLEOSYNTHESIS. Truran, J. W. (Yeshiva Univ., New York); Cameron, A. G. W. Astrophys. J.; 171: No. 1, 89-92(1 Jan 1972).

The limiting conditions consistent with p-process synthesis in supernova envelopes are inferred from calculations of the appropriate rates of proton capture and neutron photodisintegration. Temperatures in excess of 2×10^9°K are required, for proton mass densities $\sim 10^2$ g cm^{-3}, if significant production of p-process nuclei is to take place on a hydrodynamic time scale. These conditions are inconsistent with the lower temperatures ($T \sim 5 \times 10^8$°K) required in the underlying helium region for the production of ^{15}N, ^{18}O, ^{19}F, and ^{21}Ne (Howard, Arnett, and Clayton). It is concluded that these processes must be appropriate to very different stellar or supernova environments. Arguing that supernova events provide the most likely site for p-process synthesis, it is suggested that the nucleosynthesis conditions examined by Howard, Arnett, and Clayton might be realized in the helium zones of stars that experience the phenomenon of helium-burning shell flashing described by Schwarzschild and Härm. (auth)

9946 THEORETICAL PULSATION CONSTANTS AND CEPHEID MASSES. Cox, J. P. (Univ. of Colorado, Boulder); King, D. S.; Stellingwerf, R. F. Astrophys. J.; 171: No. 1, 93-102(1 Jan 1972).

Simple fitting formulae, based on extensive numerical calculations, are presented for the linear, nonadiabatic pulsation constants for the fundamental mode and first two harmonics of stellar models having radiative envelopes and He mass fraction Y ≈ 0.3. The formulae are accurate to within a few percent over very wide ranges of stellar parameters. These ranges include classical Cepheids and other familiar types of pulsating stars. The formulae are applied to a sample of classical Cepheids to estimate their masses on the basis of radii reported in the literature, under various assumptions regarding the pulsation mode. It is concluded, in part from stability considerations, that the most likely mode for most of these stars is the fundamental. The resulting masses show considerable scatter about the masses based on evolution theory without mass loss, but average some 15% smaller than these masses. However, the uncertainties in both sets of masses are so large that it is questionable whether this difference can be considered significant. (auth)

9947 PULSATIONS OF POLYTROPIC MASSES IN RAPID, UNIFORM ROTATION. Lebovitz, N. R.; Russell, G. W. (Univ. of Chicago). Astrophys. J.; 171: No. 1, 103-5(1 Jan 1972).

The variational principle for the oscillations of gaseous masses is used to find the effect of a uniform rotation, which is not assumed slow, on the fundamental pulsation frequency of a polytrope of index n = 3. The results are compared with perturbation calculations based on the assumption that the rotation is slow. The agreement between the two sets of results is very close, the principal difference being a slight increase of each pulsation frequency over that predicted by the perturbation procedure. (auth)

9948 MOMENT METHOD IN RELATIVISTIC RADIATIVE TRANSFER. Anderson, J. L. (Stevens Inst. of Tech., Hoboken, N. J.); Spiegel, E. A. Astrophys. J.; 171: No. 1, 127-38(1 Jan 1972).

The moment method of Grad is applied to the problem of radiative transfer in a medium with relativistic differential motions. If a mean absorption coefficient is used, the method readily leads to a closed system of equations. The first approximation gives the relativistic analog of the classical Eddington approximation. In the limit of small photon mean free path, the Eddington approximation does not reproduce Thomas's radiative-viscosity terms which were derived from the exact transfer equation. To recover Thomas's results it is necessary to go to the second approximation. It is suggested that this second approximation will be of use when scales of interest are not optically thick, although in general, such problems may be fairly complicated. (auth)

9949 MULTICOLOR PHOTOMETRY OF SUPERGIANTS AND CEPHEIDS. Kelsall, Thomas. College Park, Md.; Univ. of Maryland (1971). 238p. University Microfilms Order No. 72-1641.

Thesis.

Results of photometry of supergiants and Cepheids in a seven-filter system are presented. A color index was used in combination with other colors to produce four indices freed from the effects of interstellar reddening. These four indices gave measures of the Balmer discontinuity, effects of the metallic line absorption in the violet region of the spectra, break in the spectrum across the G-band, and the strength of the cyanogen-band head at 4216Å. The separation of supergiants from stars of other luminosity classes was possible. This was performed by a nonlinear mapping of the colors onto an M_v, $\log T_e$ H–R diagram. Population discrimination for Cepheids appears impossible from a study of the colors. However, it is shown that the values of various color–color loop areas can be used to distinguish Cepheids of Pop. I and Pop. II. This procedure is superior as it is independent of interstellar reddening. The Balmer discontinuity index for supergiants and Cepheids is insensitive to the effects of line blanketing. It is speculated that this will allow for a precise calibration in terms of gravity. The strengths of the metallic line absorption and CN absorption are strongly correlated. No obvious correlation was found between galactic position and chemical composition, as indicated from the strength of the metallic line index. (Diss. Abstr. Int., B)

9950 NONSPHERICAL PERTURBATIONS OF RELATIVISTIC GRAVITATIONAL COLLAPSE. Price, Richard Henry. Pasadena, Calif.; California Inst. of Tech. (1971). 141p. University Microfilms Order No. 72-482.

Thesis.

It is known that there can be no gravitational-, electromagnetic-, or scalar-field perturbations (except angular momentum) of a Schwarzschild black hole. A gravitationally collapsing star with nonspherical perturbations must therefore radiate away its perturbations or halt its collapse. The results of computations in comoving coordinates are presented to show that the scalar field in a collapsing star neither disappears nor halts the collapse, as the star passes inside its gravitational radius. On the star's surface, near the event horizon, the scalar field varies as $a_1 + a_2 \exp(-t/2M)$ due to time dilation. The dynamics of the field outside the star can be analyzed with a simple wave equation containing a space–time-curvature induced potential. This potential is impenetrable to zero-frequency waves and thus a_1, the final value of the field on the stellar surface, is not manifested in the exterior; the field vanishes. The monopole perturbation falls off as t^{-2}; higher l-poles fall off as $\ln t/t^{2l+3}$. The analysis of scalar-field perturbations works as well for electromagnetic and gravitational perturbations and also for zero-rest-mass perturbation fields of arbitrary integer spin. All these perturbation fields obey wave equations with curvature potentials that differ little from one field to another. For all fields, radiatable multipoles (l ≥ spin of the field) fall off as $\ln t/t^{2l+3}$. (Diss. Abstr. Int., B)

9951 TIME VARIATIONS IN THE EMISSION LINES OF Of STARS. Brucato, Robert Joseph. Evanston, Ill.; Northwestern Univ. (1971). 98p. University Microfilms Order No. 71-30,756.

Thesis.

Spectrograms covering the region between H_δ and H_γ at a reciprocal dispersion of 28 Å/mm were obtained for the Of stars HD 108, HD 188001, HD 190429N, HD 192639, HD 210839, and, at 42 Å/mm, HD 66811. Equivalent widths were measured for several spectral features, particularly N III λλ4634-40-41 and He II λ4686. The strengths of these lines are shown to vary in several of these stars on time scales on the order of ten minutes, with the most striking changes occurring at λ4686 in the earliest spectral types. Excitation mechanisms for producing the emission lines of N III and He II are discussed. Results of a statistical equilibrium calculation for N III suggest that the emission is the result of non-LTE effects within the stellar atmosphere and not the Bowen mechanism. (Diss. Abstr. Int., B)

9952 LARGE-RADIAL-VELOCITY STARS IN THE WING OF THE SMALL MAGELLANIC CLOUD. Carozzi, N. (Observatorie, Marseille). Astron. Astrophys., Suppl. Ser.; 4: No. 3, 231-40(Oct 1971). (In French).

Forty-nine early stars with high radial velocity were measured on objective prism plates in the wing of the Small Magellanic Cloud. Twenty of them can be found in Sanduleak's lists, but twenty-nine are unknown stars. Accurate radial velocities and spectral types on RV Cas spectrograms (73 Å/mm) were determined for five. (auth)

9953 CATALOG OF GALACTIC STAR CLUSTERS OBSERVED IN THREE COLORS. Becker, W.; Fenkart, R. (Univ., Basel). Astron. Astrophys., Suppl. Ser.; 4: No. 3, 241-52(Oct 1971).

A catalog of 216 galactic star clusters is given for which observations in three colors are available. The distances were calculated or recalculated using the method A, applied at the Basel Observatory. (auth)

9954 SPECTROSCOPIC BINARIES: 11th COMPLEMENTARY CATALOG. Pedoussaut, A.; Ginestet, N. (Observatoire, Pic du Midi, France. Observatoire, Toulouse). Astron. Astrophys., Suppl. Ser.; 4: No. 3, 253-64(Oct 1971). (In French).

This catalog is a continuation of the ten catalogs published in the "Annales de l'Observatoire astronomique et météorologique de Toulouse." The orbital elements of the known or not-yet-known spectroscopic binaries are given; an orbital calculation of them was done and its corresponding publication was received. It is pointed out that our "Fichier général des binaires spectroscopiques" is almost complete: every binary has an index card showing all its calculated orbits. (auth)

9955 LIGHT CURVE PARAMETERS OF PHOTOELECTRICICALLY OBSERVED GALACTIC CEPHEIDS. Schaltenbrand, R.; Tammann, G. A. (Univ., Basel). Astron. Astrophys., Suppl. Ser.; 4: No. 3, 265-314(Oct 1971).

The UBV light-curve parameters of 323 galactic Cepheids were derived from nearly 12,000 photoelectric observations by Fourier analysis. (auth)

9956 INTERPRETATION OF THE MINKOWSKI BANDS IN Grw +70°8247. Angel, J. R. P. (Columbia Univ., New York). Astrophys. J.; 171: No. 1, L17-21(1 Jan 1972).

It is argued from the spectral structure of circular polarization in Grw + 70°8247 that the absorption bands are, at least in part, molecular in origin. The spectrum of molecular helium has strong bands coincident with several of the Minkowski bands and, in particular, at high temperature shows a strong band head at ~4125 Å. Helium molecules could be formed in sufficient density to give the absorption features in the star if it has a pure helium atmosphere. The Zeeman effect in molecular helium can explain, in general, the observed spectral features in the polarization and also may be responsible for the continuum polarization. (auth)

9957 SPECTRAL DEPENDENCE OF CIRCULAR POLARIZATION IN Grw +70°8247. Angel, J. R. P. (Columbia Univ., New York); Landstreet, J. D.; Oke, J. B. Astrophys. J.; 171: No. 1, L11-15(1 Jan 1972).

Sharp changes in circular polarization with wavelength were seen in new observations of Grw + 70°8247 made with 80 Å resolution. Some of the structure was associated with the Minkowski bands. Continued broad-band measurements showed that, while the polarization below 6000 Å appeared to remain constant, above this wavelength there have been significant changes in the past year. (auth)

9958 EFFECTS OF X-RAY STARS ON VLF SIGNAL PHASE. Svennesson, J. (Geophysical Observatory, Kiruna, Sweden); Reder, F.; Crouchley, J. J. Atmos. Terrest. Phys.; 34: No. 1, 49-72(Jan 1972).

Stellar x-ray effects from Sco XR-1, Cen XR-2, and Cen XR-4 were found on several of the numerous vlf phase recordings collected on a world-wide basis since 1965. Only marginal vlf phase anomalies could be associated with Tau XR-1, and none with the Sco XR-1 flares of June 3, 1967. Stellar vlf-phase effects are more pronounced at higher signal frequencies and on vlf paths with long nighttimes. Scattered L_α radiation after sunset and before sunrise reduces the sidereal shift of vlf effects on E ⇀ W paths; and the closeness of the signal path position to the solar terminator at local midnight can shift the date when a maximum stellar vlf phase anomaly is observed. A detectability factor is defined which compares expected stellar effects on arbitrary signal paths to the established effect of Sco XR-1 on the 22.3-kHz signal from NWC to Tananarive. In 1968, Sco XR-1 caused a maximum phase advance of ~0.6 μsec/Mm on NWC (22.3 kHa)—Tananarive; Cen XR-2 and Cen XR-4 increased their x-ray flux to about that of Sco XR-1 on or about March 7, 1967 and July 6, 1969, respectively; Cen XR-2 flux peaked ~March 27 and possibly ~April 10 and decreased rapidly between April 20 and May 10, 1967. It is concluded that (a) presently known stellar x-ray sources are not detrimental to the accuracy of the OMEGA navigational system; (b) the permanent x-ray stars may give rise to a seasonal variation of nighttime phase at frequencies above 15 kHz; and (c) continuous vlf phase tracking at frequencies above 20 kHz can provide some valuable astrophysical information complementing space probe data. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 9364, 9365, 9380, and 10143.

9959 INTERSTELLAR SODIUM LINES AND THE TWO-COMPONENT MODEL OF GALACTIC H I REGIONS. Hobbs, L. M. (Univ. of Chicago); Zuckerman, B. Astrophys. J.; 171: No. 1, 17-20(1 Jan 1972).

The intensities and widths of the interstellar sodium lines are considered as possible discriminants between two different two-component models recently proposed for galactic H I regions. Depending on the model, the observed sodium lines are either formed entirely in the clouds or, alternatively, in both the clouds and the intercloud medium. Present observational evidence is insufficient to distinguish between these two possibilities. (auth)

9960 GAMMA-RAY OBSERVATIONS OF THE GALACTIC CENTER AND SOME POSSIBLE POINT SOURCES. Fichtel, C. E.; Hartman, R. C.; Kniffen, D. A.; Sommer, M. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 1, 31-40(1 Jan 1972).

A 0.5 × 0.5 m digitized spark-chamber γ-ray telescope was flown on three balloon flights to look at the galactic center region, Virgo, and the Crab Nebula. An excess flux above atmospheric background of over 4 standard deviations was found for γ rays exceeding 100 MeV coming from the galactic center region, corresponding to a line intensity of $(2.0 \pm 0.6) \times 10^{-4}$ γ $(cm^2\ rad\ s)^{-1}$, but there was no statistically significant excess in the 50 to 100-MeV interval, with a 95% confidence limit for the ratio [J(50 to 100 MeV)/J(>100 MeV)] being 0.50. As a result, there is only a 6% chance that Compton or synchrotron radiation from electrons with a power-law spectrum having an exponent of 2.6 could make as much as a 50% contribution to the γ radiation in this energy range. No positive evidence was found for radiation from any of the sources M87, 3C 273, or the Crab Nebula, and 95% confidence upper limits for the γ-ray flux from these objects were set at 1.0×10^{-5}, 1.0×10^{-5}, and 6×10^{-5} $(cm^2\ s)^{-1}$, respectively. The M87 limit eliminates the possibility that the power-law spectrum observed at x-ray energies extends unchanged to the high-energy γ-ray region. (auth)

9961 ABSOLUTE FLUX-DENSITY MEASUREMENTS AT CENTIMETER WAVELENGTHS. Medd, W. J. (National Research Council of Canada, Ottawa). Astrophys. J.; 171: No. 1, 41-50(1 Jan 1972).

Flux density measurements of Cas A, Tau A, Cyg A, and the Orion Nebula were made at 4.5 cm; also, measurements of Cas A and Tau A at 2.2 cm. The results are summarized. The experimental procedure is outlined and the accuracy of the results examined in detail. (auth)

9962 X-RAY SPECTRA OF DISCRETE SOURCES IN CYGNUS. Bleach, R. D.; Boldt, E. A.; Holt, S. S.; Schwartz, D. A.; Serlemitsos, P. J. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 1, 51-4(1 Jan 1972).

X-ray spectral data from a rocket-borne proportional counter exposure to discrete sources in Cygnus are presented. The data from Cyg X-1, Cyg X-2, and Cyg X-3 have sufficient statistical significance to clearly indicate mutually exclusive spectral forms for the three. Upper limits are presented for x-ray intensities above 2 keV for Cyg X-4 and Cyg X-5 (Cygnus Loop). (auth)

9963 80-MHz OBSERVATIONS OF THE SCORPIUS X-1 SOURCE. Slee, O. B.; Higgins, C. S. (CSIRO, Sydney). Nature (London): 234: No. 5326, 210(26 Nov 1971).

Previous observations of the region of the strong x-ray source Sco X-1 are briefly reviewed. In particular, a high-resolution study of the region by Hjellming and Wade (Astrophys. J., 164: L1(1971)) at 2,695 and 8,085 MHz clearly showed the presence of three closely spaced sources; the central source was found to be highly variable over a period of hours and was identified with the optical object associated with the x-ray source, and it was noted that its flare emission tended to be considerably stronger at 2,695 than at 8,085 MHz, with spectral indices up to 1.5. Unsuccessful attempts were made to detect the source at lower frequencies by Apparao and others. During four nights in May and July 1971 the 80-MHz radioheliograph at Culgoora, NSW, was used to observe the Sco X-1 region for a total of 14 hr.; no source was detected. It was concluded that the high spectral indices found by Hjellming and Wade are not continued into the low-frequency end of the spectrum. (UK)

9964 MECHANISM FOR THE DELAY OF POLARISATION MINIMA IN THE OPTICAL PULSAR NP 0532. Ferguson, D. C. (Univ. of Arizona, Tucson). Nature (London) Phys. Sci.; 234: No. 48, 86-7(29 Nov 1971).

A simple explanation of the delay of the polarization minima after the pulse peaks is claimed. It is assumed that the optical emission from the pulsar has a power law spectrum $I_\nu \alpha \nu^{-\epsilon}$, so that its shape is unchanged by Doppler shifts, and that the emission comes from localized regions of the magnetic field where the field lines are moving relativistically with respect to the observer and is predominantly along a magnetic field line. The amount of linear polarization is assumed to be at a minimum for emission in a direction of a magnetic field line. A delay in the polarization minimum from the pulse peak may arise from the relativistic beaming of radiation from a localized emitting region orbiting relativistically around a neutron star, with the emission maximum in the direction of a magnetic field line in the emitting frame. The amount of the polarization delay varies with the emission pattern in the emission frame, the velocity, and the tilt of the rotation axis. An attempt is being made to ascertain if the polarization delays of the principal pulse and of the subpulse can be fully explained by the method outlined. (UK)

9965 TWO VARIABLE RADIO SOURCES. MacDonell, D. G.; Bridle, A. H. (Queen's Univ., Kingston, Can.). Nature (London) Phys. Sci.; 234: No. 48, 88-90(29 Nov 1971).

It was found that the small-diameter radio sources DW 0224 + 67 and DW 0727-11 (see Nature, 227: 582 (1970)) have shown large variations in flux density at microwave frequencies since Nov. 1968. The observations were made at 3.24, 6.63, and 10.6 GHz with the 46-m paraboloid at the Algonquin Radio Observatory. Measurements at 6.63 and 10.6 GHz were corrected for the linear polarization of the calibration source and for the instrumental polarization, thereby raising the flux densities given in the above reference. There was no significant correction at 3.24 GHz. Comparison is made with the observations of other workers. In the case of DW 0224 + 67, the 10.6-GHz flux density reached a maximum near the end of Aug. 1969; at 6.63 GHz the maximum occurred near the end of Nov. 1969, whilst at 3.24 GHz it had probably not occurred by Feb. 1970, when regular monitoring at this frequency was discontinued. In the case of DW 0727-11 between Nov. 1968 and March 1969 the 6.63- and 10.6-GHz flux densities both increased to $\sim 3.7 \times 10^{-26}$ W/m^2/Hz, at which level they appear to have remained until late 1969. At 10.6 GHz the flux density increased to 3.7×10^{-26} by Jan. 1970. The few available data on linear polarization of DW 0727-11 suggest that the source is nonthermal. (UK)

9966 RADIO EMISSION FROM THE SUPERNOVA REMNANT PUPPIS A. Green, Anne J. (Univ. of Sydney). Aust. J. Phys.; 24: No. 5, 773-4(Oct 1971).

A radio map is presented of the well-known supernova remnant Puppis A at 408 MHz has been produced from observations with the Molonglo radio telescope. The object has been studied by many observers but the present map has the highest resolution yet attained, with an effective beamwidth of 2.86′ (R.A.) by 2.88′ (Dec.). (auth)

9967 LOW-LATITUDE SURVEY FROM l = 355° TO 5° AT 1410 MHz. Sinclair, M. W.; Kerr, F. J. (CSIRO, Epping, Australia). Aust. J. Phys.; 24: No. 5, 769-72(Oct 1971).

A contour map is presented of the region of the Milky Way between longitudes 355 and 5° and latitudes ±2° at 1410 MHz. A list of sources is also given with values of peak antenna temperature and flux density. (auth)

9968 SUPERNOVA OF 1006 A.D. Milne, D. K. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 24: No. 5, 757-67(Oct 1971).

A radio investigation is presented of the region in Lupus believed to contain the supernova of 1006 A.D. These observations, which were made with the Parkes 64-m telescope, show a spur or plateau extending from the galactic plane. There are two probable supernova remnants near the position of SN 1006: a large diffuse shell source, the "Lupus Loop," and a more compact object, MSH 14−41$\underline{5}$, believed to be the remnant of the 1006 A.D. event. The radio emission from both of these sources is strongly polarized. (auth)

9969 OBSERVATIONS AT 408 MHz OF RADIO SOURCES FROM THE 4C CATALOGUE. III. STUDIES OF IDENTIFIED SOURCES. Munro, R. E. B. (Univ. of Sydney). Aust. J. Phys.; 24: No. 5, 743-55(Oct 1971).

A sample of 4C sources selected from the data of Parts I and II, which contained details of observations at 408 MHz of 586 radio sources in the −7° to 0° declination region and suggested identifications for 170 of them, was considered. The sample was essentially complete down to 2 f.u. at 178 MHz and contained 416 sources of which 152 were identified. It was used to study a number of properties of radio sources, including the relation between the emission from associated radio and optical objects, the ratio of galaxies to quasi-stellar sources among radio sources, the angular extent of the sources, the distribution of the radio spectral indices, and the source-count relationship. (auth)

9970 OPTICAL OBJECT IDENTIFIED WITH 3C 455. Arp, H. C. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Burbidge, E. M.; Mackay, C. D.; Strittmatter, P. A. Astrophys. J.; 171: No. 1, L41-3(1 Jan 1972).

It is shown that the optical object identified with 3C 455 is a quasi-stellar object with a redshift z = 0.543. The QSO is situated 23″ northeast of the S0 galaxy NGC 7413, which has a redshift of 0.0332. (auth)

9971 X-RAY SPECTRUM OF NGC 5128. Lampton, Michael; Margon, Bruce; Bowyer, Stuart; Mahoney, William; Anderson, Kinsey (Univ. of California, Berkeley). Astrophys. J.; 171: No. 1, L45-50(1 Jan 1972).

The x-ray spectrum of NGC 5128 (Cen A) obtained by sounding rocket and balloon observations is presented in the range 1 to 180 keV. NGC 5128 may be fitted by a power law with a photon index $-2 \leq n \leq -1.45$. Inverse Compton models are presented, and constraints on their parameters are discussed. In all such models, the electrons and magnetic field have not yet equilibrated. Alternatively, the x rays may originate in a compact central core source. (auth)

9972 GENERAL SURVEY OF 21-cm LINE RADIATION AT HIGH GALACTIC LATITUDES ($|b| \geq 15°$). Tolbert, Charles R. Astron. Astrophys., Suppl. Ser.; 3: No. 5, 349-454(Jun 1971).

A general survey of 21-cm line radiation was made on a grid of 5° or less for galactic latitudes $|b| \geq 15°$. The observations were made with the 25-m telescope at Dwingeloo with a half-power beamwidth of 0.6° and using a bandwidth of 16 kHz. This material is presented in the form of a profile atlas (Part VII of the "Dwingeloo Atlas of 21-cm Profiles") and as contour diagrams. The hydrogen columnar density was determined as a function of velocity at each observed position and the general distribution determined. (auth)

9973 DETECTION OF STRONG INTERPULSES FROM NP 0532. Gower, J. F. R.; Argyle, Edward (Dominion Radio Astrophysical Observatory, Penticton, British Columbia). Astrophys. J.; 171: No. 1, L23-6(1 Jan 1972).

Observations of NP 0532 at 146 MHz show that the sporadic bright pulses are associated with the interpulse as well as with the main pulse. Roughly 8% of the strong pulses occur at the time of the interpulse, and the remaining 92% are associated with the composite main pulse. Both types of pulse have the same shape, which agrees well with predictions based on the theory of interstellar multipath scattering. (auth)

9974 PERIODICITY IN THE RADIOFREQUENCY SPECTRUM OF THE PULSAR CP 0328. Sturrock, P. A.; Antiochos, S.; Switzer, P.; Vallee, J. (Stanford Univ., Calif.). Astrophys. J.; 171: No. 1, L27-30(1 Jan 1972).

Long-term averaging of a sequence of wide-band radiofrequency spectra of CP 0328 reveals a periodicity not apparent in the original spectra. This may be caused by a mechanism intrinsic to the source, or by a propagation mechanism distinct from ordinary scintillation. (auth)

Solar Phenomena

Refer also to abstracts 9381 and 10472.

9975 (NBS-SPEC. PUBL-353) MENZEL SYMPOSIUM ON SOLAR PHYSICS, ATOMIC SPECTRA, AND GASEOUS NEBULAE. Proceedings of a Symposium held at the Harvard College Observatory, Cambridge, Massachusetts, April 8-9, 1971. Gebbie, Katharine B. (ed.) (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Aug 1971. 213p. (CONF-710440). GPO $1.75.

A symposium in honor of Donald H. Menzel's contributions to astrophysics was held on his 70th birthday at the Harvard College Observatory, Cambridge, Massachusetts, April 8–9, 1971. Menzel and his co-workers have made distinguished contributions to the theory of atomic physics, solar physics, and gaseous nebulae. The work on planetary nebulae represented the first investigations of nonequilibrium thermodynamic conditions in astronomy; the solar work extended these investigations to stellar atmospheres. The applied atomic physics laid the basis for what is now called laboratory astrophysics and, together with work on nonequilibrium thermodynamics, inspired the founding of the Joint Institute for Laboratory Astrophysics. The papers summarize the current status of work in the three fields he pioneered. (auth)

9976 SOLAR WIND CONFERENCE, MARCH 21–26, 1971. Russell, Christopher T. (Univ. of California, Los Angeles). Earth Extraterr. Sci.; 1: No. 8, 219-28(Nov 1971).

The second Solar Wind Conference was held at Pacific Grove, California. The purpose of the conference was to review the knowledge of the solar wind gained since the first conference at Pasadena and to delineate clearly the problems still remaining. The contents of each session are summarized. The conference proceedings were slated for publication in late 1971. (W.D.M.)

9977 MICROWAVE SOLAR RADIOMETER AT 2800 MHz. Narayanan, K.; Bhonsle, R. V. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A; 142-51 (Sep 1971).

A Dicke-type microwave radiometer was developed for daily measurement of solar flux at 2800 MHz. The antenna system consists of a 5-foot parabolic dish with horn feed, is equatorially mounted, and is capable of tracking the Sun for about 8 hours each day. The dynamic range of the radiometer is such that even strong solar bursts (flux = $10{,}000 \times 10^{-22}$ watts m^{-2} Hz^{-1}) can be recorded by using the receiver in the AGC mode. The calibration procedure and the errors involved in the measurement of the solar flux are briefly discussed. Some sample records of solar bursts made by means of this equipment are presented. (auth)

9978 K-CORONA AND ELECTRON DENSITY. Rybansky, M. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 22: No. 5, 321-4(1971).

A method is described for the determination of the intensity of the K-corona from photographs of the corona spectrum taken without the eclipse. Further, a simple method is submitted to determine the electron density from the K-corona intensity in coronal condensations. (auth)

9979 OBSERVATIONS OF SOLAR FLARES AT ONDREJOV OBSERVATORY DURING THE YEAR 1970. Hrebik, F.; Kvicala, J.; Krivsky, L., Olmr, J. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 22: No. 5, 305-20(1971).

This paper is a continuation of twelve preceding reports (which contained chromospheric flares observed at Ondřejov Observatory from 1948 up to the end of 1969) and covers the period of 1970. The data, about 208 flares, associated 9,400-, 808-, 536-, and 260-MHz events and 27-KHz SEA observed and recorded during 1970, are summarized. The corresponding curves of the H_α line-width changes are plotted. The net times of observations of the chromosphere made by a spectrohelioscope and the net times of measurements of the solar flux at 536 MHz are also given. (auth)

9980 NUCLEAR COMPOSITION AND ENERGY SPECTRA IN THE APRIL 12, 1969, SOLAR-PARTICLE EVENT. Bertsch, D. L.; Fichtel, C. E.; Reames, D. V. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 1, 169-77(1 Jan 1972).

The charge composition for several of the multicharged nuclei and the energy spectra for hydrogen, helium, and medium ($6 \leq Z \leq 9$) nuclei were measured in the April 12, 1969 solar-particle event. The energy/nucleon spectral shape of the medium nuclei was again the same as that of the helium nuclei, and the ratio of these two species was consistent with the present best average of 58 ± 5. By combining the results with previous work, improved estimates of the Ne/O and Mg/O values of 0.16 ± 0.03 and 0.056 ± 0.014, respectively, were obtained. Silicon and sulfur abundances relative to O were determined to be 0.208 ± 0.010 and 0.008 ± 0.006, respectively, and 85% confidence upper limits for Ar and Ca relative to O of 0.017 and 0.010 were obtained. Previously, these last four nuclei had only been listed as a group. (auth)

9981 SOLAR ABUNDANCE OF SILICON FROM FORBIDDEN LINES OF Si I. Grevesse, N. (Univ., Liege); Swings, J. P. Astrophys. J.; 171: No. 1, 179-84(1 Jan 1972).

The low-excitation (E.P. = 0.78 eV) [Si I] line at 10,991.41 Å is blended by a telluric water-vapor line when observed at the center of the solar disk, but can be detected on Doppler-shifted spectra obtained at the west limb of the Sun. A description of observations at $\mu = \cos\theta = 1.0$ and at $\mu = 0.2$, 0.13, and 0.11 is given. The intensity of the line detected near the limb, which is attributed to [Si I], leads to a solar silicon abundance in agreement with the value deduced from higher-excitation permitted lines (E.P. > 5 eV) and from extreme-ultraviolet coronal lines, i.e., $\log N_{Si} = 7.5$ (if $\log N_H = 12.00$). Future observations of infrared [Si I] lines on the disk and in sunspots are envisaged. (auth)

9982 MISSING SOLAR ULTRAVIOLET OPACITY AND DIATOMIC MOLECULES. Tarafdar, S. P.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Astrophys. J.; 171: No. 1, 185-90(1 Jan 1972).

The band absorption coefficient of some of the molecules abundant in the solar photosphere was compared with the total absorption coefficient of metals and hydrogen. It was found that the band absorptions considered are possibly large enough to account for the missing opacity in the solar ultraviolet spectrum, except in a small interval between 2500 and 3000 Å. (auth)

9983 SOLAR RADIO RECOMBINATION LINES. Berger, P. S.; Simon, M. (State Univ. of New York, Stony Brook). Astrophys. J.; 171: No. 1, 191-200(1 Jan 1972).

A search at 85 to 92 GHz for solar recombination lines was carried out, particularly those in which dielectronic recombination is expected to overpopulate the high-n states. Observations were made at the frequencies of hydrogen and helium and all ions up to Z = 15. Upper limits for the strengths of the lines were an order of magnitude lower than those that had previously been predicted. The dielectronic recombination rates of Shore were used to revise the theoretical estimates, and the revised estimates were found to be consistent with the observations. Criteria were developed for selecting detectable ions, and the strengths of their lines in the radio and far-infrared regions were estimated. (auth)

9984 MODEL OF AN OSCILLATORY HYDROMAGNETIC DYNAMO. II. Getling, A. V.; Tverskoi, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 330-4(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 389-5(1971).

The possibility of generation of a regular large-scale solar magnetic field by convective currents in the sun's outer shell is investigated. A cyclic process where toroidal eddies with an azimuthal circulation of matter arise periodically during part of the cycle in the outer shell of a fluid conducting sphere, rotating nonuniformly, is used as a model of the dynamo process. Ohmic diffusion of the magnetic field takes place in the same region, while the field does not penetrate into the inner part of the sphere where conductivity is very high. Solutions of the equation of electromagnetic induction for the magnetic field in a toroidal eddy and in the nonuniformly rotating spherical shell are used to analyze the action of a dynamo of this type. The azimuthal component of the large-scale field forms as a result of meridional differential rotation and the poloidal component is formed from the azimuthal by eddy currents and subsequent attenuation of the higher harmonics. (auth)

9985 INVESTIGATION OF THE EFFECT OF DIRECTIVITY OF RADIO EMISSION OF TWO LOCAL SOURCES ON THE SUN AT 0.8, 1.3, 3.2, 9.1, 21, AND 43 cm. Grebinskii, A. S.; Tsyganov, A. N. Vestn. Leningrad. Univ., No. 13, Ser. Mat., Mekh. Astron.; No. 3, 151-8(Jul 1971). (In Russian).

A complex investigation of two groups of local sources on the Sun at 0.8, 1.3, 3.2, 9.1, 21, and 43 cm was made. The variation of the brightness temperature, the dimensions, and the absolute fluxies of the local sources during their existence on the Sun was studied. The strong darkening to the limb at 0.8 cm and 43 cm was detected and is discussed. (auth)

9986 CENTER-TO-LIMB VARIATION OF THE PEAK FLUX SPECTRA OF TYPE-IV RADIO BURSTS ASSOCIATED WITH SOLAR PROTON FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 19: No. 12, 1685-91(Dec 1971).

Type-IV radio bursts with wide band from microwave to metric-wave frequency are generally associated with solar-proton flares. Recently, Castelli et al. (1967, 1968) showed that the type-IV radio

bursts associated with solar-proton flares show the U-shaped peak flux spectra with the minimum flux at decimetric frequencies. In this paper, the center-to-limb variation of such peak flux spectra is investigated in order to examine the effect of decrease of the peak flux at metric frequencies with increase of the angular distance from the central meridian of the Sun. It is shown that the U-shaped spectra are obtained independent of the position of proton flares, although the spectral form changes significantly in the case of the flares near the limb. It is further suggested that the U-shaped spectra consist of the two essentially independent components for microwave and metric-wave frequencies, respectively. (auth)

9987 RADIO SCINTILLATIONS DUE TO PLASMA IRREGULARITIES WITH POWER LAW SPECTRA: THE INTERPLANETARY MEDIUM. Matheson, D. N.; Little, L. T. (Univ. of Kent, Canterbury, Eng.). Planet. Space Sci.; 19: No. 12, 1615-24 (Dec 1971).

Scintillation effects produced when radiation is incident on a medium containing phase-changing irregularities that have power-law spectra are discussed. The results are then applied to the interplanetary medium, and it is concluded that the small-scale sizes (~100 km) for irregularities measured by interplanetary scintillation represent a genuine "outer scale" distinct from the 10^6-km scales detected by space probes. It is also shown that the small-scale irregularities contain discontinuities that are finite or almost finite, with a sharpness as yet undetermined. (auth)

9988 PARTICLE ACCELERATION IN SOLAR FLARES. Miroshnichenko, L. I. Priroda; No. 7, 37-41(Jul 1971). (In Russian).

Energy release in a solar flare occurs in 100 to 1,000 sec, and may reach 10^{32} ergs in a volume of 10^{28} to 10^{29} cm^3. Particle acceleration takes place with energies of 10^6 to 10^{10} eV (for protons), and may continue out into interplanetary space. S. I. Syrovatskii proposed a model in which the energy of a magnetic field is dissipated that may explain the source of this amount of energy. The phenomena of sunspots, cosmic rays, turbulent currents, the quiescent and explosive phases of a flare, energy loss through electron–ion collisions, spectra of the accelerated protons and electrons, and the density of the solar atmosphere are each briefly discussed and interpreted in terms of Syrovatskii's model. (K.S.W.)

9989 ENRICHMENT OF VERY HEAVY NUCLEI IN THE COMPOSITION OF SOLAR ACCELERATED PARTICLES. Mogro-Campero, Antonio; Simpson, J. A. (Univ. of Chicago). Astrophys. J.; 171: No. 1, L5-9(1 Jan 1972).

The abundances of the nuclei C, N, O, Ne, Mg, Si, Ar, and Ca and the group Cr–Co relative to oxygen from seven solar energetic-particle events were measured in the energy range ~14–61 MeV per nucleon with a solid-state detector telescope on the OGO-5 satellite, 1968–1971. The differential energy spectra of O (14 to 29 MeV per nucleon) and Cr–Co (3 to 61 MeV per nucleon) have a spectral index of ~(–3) for a power law in kinetic energy. The relative abundances of C, N, O, and Ne are in excellent agreement with emulsion studies. However, when compared with the solar photospheric and coronal abundances, the OGO-5 measurements show a large enhancement of relative abundances beginning with Si, and extending to the Cr–Co group. The enhancement over the solar and universal abundances is in rough agreement with the composition of the galactic cosmic radiation. (auth)

9990 PROGRESS IN THE MEASUREMENT OF ATOMIC TRANSITION PROBABILITIES AND SOLAR ABUNDANCES. Kessler, Karl G. (National Bureau of Standards, Washington, D. C.). Comments At. Mol. Phys.; 2: No. 5, 151-5(Dec 1970-Jan 1971).

A summary of traditional methods of measuring atomic transition probabilities is followed by an outline of new techniques developed in the past two decades. Inconsistencies in older data on transition probabilities and solar abundance of iron are discussed briefly. Results of measurements of transition probabilities of iron by Bridges and Wiese (Astrophys. J., 161: L71(1970)) are presented and compared with results of other recent measurements. The agreement is considered impressive. When applied to solar data, the new values bring the calculated photospheric abundance up by about a factor of ten, which clears up a previous inconsistency. (A.G.W.)

Galaxies

9991 ADDITIONAL SCRUTINY OF A PROPOSED TEST FOR CLUSTER EXPANSION. Rood, Herbert J. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 171: No. 1, 1-3 (1 Jan 1972).

If a centrally concentrated cluster is expanding because a force has accelerated the galaxies outward, its velocity dispersion does not decrease from the cluster center to its borders, but first increases from the center to a "turnover radius." (auth)

9992 EMISSION-LINE INTENSITIES AND UBV MAGNITUDES FOR TWENTY-THREE MARKARIAN GALAXIES. Weedman, Daniel W. (Vanderbilt Univ., Nashville). Astrophys. J.; 171: No. 1, 5-12(1 Jan 1972).

Intensities for the [O III] λλ4959, 5007 emission lines were measured with a photoelectric spectrum scanner to calibrate spectrophotometry for 23 representative objects from Markarian's list of galaxies with strong ultraviolet continua. The 23 objects include 10 galaxies that resemble the Seyfert galaxies, two galaxies with strong but narrow nuclear emission lines, and 11 diffuse galaxies. The Hβ luminosities do not vary greatly among the Seyfert-like Markarian galaxies, but these luminosities generally exceed those found in the commonly studied Seyfert galaxies NGC 1068 and NGC 4151. The Hβ luminosities from the diffuse Markarian galaxies vary by more than a factor of 100. UBV magnitudes are given for 24 Markarian galaxies, and the Seyfert-like galaxies are clearly separated from the diffuse galaxies in the color–color diagram. (auth)

9993 INTEGRAL-SIGN GALAXY MCG 12-7-28. Richer, Harvey B. (Univ. of Rochester, N. Y.); Sharpless, Stewart; Olson, B. Ingemar. Astrophys. J.; 171: No. 1, 13-16(1 Jan 1972).

Some properties of a peculiar galaxy with the apparent shape of an integral sign are discussed. (auth)

9994 PHOTOCHEMISTRY AND LIFETIMES OF INTERSTELLAR MOLECULES. Stief, L. J.; Donn, B.; Glicker, S.; Gentieu, E. P.; Mentall, J. E. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 1, 21-30(1 Jan 1972).

A quantitative discussion is given of the photochemistry and lifetime against photodecomposition of five interstellar molecules: H_2CO, NH_3, H_2O, CH_4, and CO. For the first four molecules, primary photochemical decomposition processes yielding atomic and molecular hydrogen are considered in addition to photoionization. The quantum yield for decomposition of these molecules is unity. For CO, only decomposition to ground-state carbon and oxygen occur, but the quantum yield is not known and may be considerably less than unity. For the interstellar radiation field, the results of Habing, who obtains a uniform energy density $U_\lambda = 40 \times 10^{-18}$ ergs cm^{-3} $Å^{-1}$, are adopted. The radiation field in obscuring clouds is estimated, using an interstellar extinction curve for the Perseus region. The calculations indicate that in unobscured regions all molecules considered except CO have comparable lifetimes of less than 100 years. The CO lifetime will be 10^2 to 10^3 years for quantum yields of 1 to 0.1. These short lifetimes suggest that the molecules can never have been exposed to unobscured radiation from the time of their formation until protected in clouds. It implies that polyatomic molecules were formed or released in the gas phase in the clouds where they now occur. Calculations of lifetime as a function of cloud opacity show that for clouds of moderate opacity (a few magnitudes extinction in the visual), polyatomic molecules have lifetimes against photodecomposition of the order of 10^6 years. (auth)

9995 PHOTOIONIZATION AND ABSORPTION SPECTRUM OF FORMALDEHYDE IN THE VACUUM ULTRAVIOLET. Mentall, J. E. (Goddard Space Flight Center, Greenbelt, Md.); Gentieu, E. P.; Krauss, M.; Neumann, D. J. Chem. Phys.; 55: No. 12, 5471-9(15 Dec 1971).

Absorption and photoionization coefficients were measured for H_2CO in the 600 to 2000-Å region. Integrated oscillator strengths were determined for a number of strong Rydberg transitions above 1200 Å. From the photoionization curve the first adiabatic ionization potential was found to be 10.87 ± 0.01 eV. As an aid in interpreting the absorption spectrum, theoretical calculations were made using a single-configuration self-consistent field procedure for the Rydberg states and a model which included mixing between the Rydberg and valence states. On this basis, weak absorption features between 1340 and 1430 Å were assigned to the $^1B_1(\sigma \rightarrow \pi^*)$ valence state. The $^1A_1(\pi \rightarrow \pi^*)$ valence state was deduced to be strongly autoionized just above the $^2B_2$ ionization limit. (auth)

9996 INVESTIGATION OF THE KINEMATICS OF THE IONIZED GAS IN THE PECULIAR GALAXY M82. Heckathorn III, Harry Mervin. Evanston, Ill.; Northwestern Univ. (1971). 202p. University Microfilms Order No. 71-30,828.

Thesis.

Twenty spectra were obtained of the emission halo of the peculiar galaxy M82 with a 40-inch telescope. The Meinel spectrograph was equipped with either a Westinghouse single-stage image intensifier or a Varo two-stage image intensifier. Slit orientations were parallel to the apparent major axis of the galaxy with the slit crossing the minor axis at distances as large as 45 arc seconds

from the apparent nucleus of the galaxy. The spectra record Hα, [N II]λλ6548, 6583 and [S II]λλ6717, 6731 in emission. These spectra all have one important feature in common; the emission lines are significantly tilted, indicative of a rotational velocity field in the emission halo extending considerably above and below the fundamental plane of the galaxy. The spectra were measured, and a technique was developed to remove the effects of distortion due to the use of the image intensifiers. A contour map of the velocity field as defined by the emission lines was constructed from the measured velocity curves. The conclusion was reached that the bulk of ionized gas in M82 is probably both expanding along and rotating about an axis coincident with the axis of rotation of the stellar population of the galaxy. The suitability of image intensifiers for the determination of radial velocities of emission line objects and new data-reduction techniques needed to make such studies possible are discussed. (Diss. Abstr. Int., B)

9997 SEARCH FOR FAINT COMPANIONS TO M31. van den Bergh, Sidney (Univ. of Toronto, Richmond Hill, Ont.). Astrophys. J.; 171: No. 1, L31-3(1 Jan 1972).

Three faint objects that are probably Sculptor-like dwarf galaxies were found near the Andromeda Galaxy. If these objects are at the same distance as M31, they have $M_v \approx -11$ and $0.5 \leq D(kpc) \leq 0.9$. (auth)

9998 VARIATIONS OF THE HYDROGEN LINES EMITTED BY THE NUCLEUS OF IC 450. Ulrich, Marie-Helene J. (Univ. of Texas, Austin. Institut d'Astrophysique, Paris). Astrophys. J.; 171: No. 1, L35-6(1 Jan 1972).

The component of the Balmer lines blueshifted by 3000 km s^{-1} from the systemic velocity of IC 450 and observed in 1969 and 1970 by Khachikian and Weedman is undetectable on spectra taken in 1971 February and October. This is in agreement with the calculated decrease of the intensity of the hydrogen lines emitted by a gas cloud as the gas cloud expands with a velocity of 10^3 km s^{-1} from a linear dimension of 3.2×10^{15} cm and a density of $\approx 3 \times 10^3$ cm^{-3}. (auth)

9999 GAS MOTIONS IN THE CENTER OF THE SEYFERT GALAXY NGC 7469. Ulrich, Marie-Helene J. (Univ. of Texas, Austin. Institut d'Astrophysique, Paris). Astrophys. J.; 171: No. 1, L37-40(1 Jan 1972).

Image-tube spectra of the nucleus of NGC 7469, taken with a dispersion of 28 Å mm^{-1}, show that the line [N II] λ6583 and the narrow core of Hα are resolved into two components 3.5 Å wide and separated by 3.8 Å. The observations are interpreted as evidence for the presence of two gas clouds partly overlapping along the line of sight. The gas clouds extend on 1200 pc, their mass is $>0.5 \times 10^6 M_\odot$, and their radial velocities differ by 180 km s^{-1}. (auth)

Cosmology

10000 INCREASE IN ENTROPY IN AN EXPANDING UNIVERSE. Sakai, Kazuo (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1292-3(Oct 1971).

The general relativistic fluid dynamics in the presence of dissipative processes (viscosity and thermal conductivity) was first formulated by Eckart (1940). The formulation has been applied to the investigation of the dissipation of local motions in an expanding Universe. In these formulations and applications, however, the second (volume) viscosity was neglected. In this letter, the general relativistic equations of fluid dynamics with dissipation are formulated, taking into account the second viscosity, and it is shown that their application to an expanding Universe (with no local inhomogeneities) gives two results, that is, the increase entropy and the acceleration of the expansion owing to the second viscosity. (W.D.M.)

10001 ELECTROMAGNETIC FIELDS PRODUCED BY RELATIVISTIC DISKS. Scharlemann, Ernst T.; Wagoner, Robert V. (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 171: No. 1, 107-25(1 Jan 1972).

The quasi-stationary gravitational collapse of a uniformly rotating, current-carrying relativistic thin disk was investigated. By neglecting the effects of the electromagnetic field on the gravitational field, a general solution for the electromagnetic field was found that has the same basic structure as that found by Bardeen and Wagoner for the gravitational field. Numerical results are presented for the specific case of a perfectly conducting disk having no net charge, within which the magnetic field is uniform in the Newtonian limit. These results indicate that the electromagnetic multipole moments produced by any disk with zero net charge all vanish as an event horizon forms around the disk. (auth)

10002 ELECTROMAGNETIC RADIATION IN THE UNIVERSE. Longeir, M. S.; Syunyaev, R. A. (Lebedev Inst. of Physics, Moscow. Cambridge Univ., Eng. Inst. of Applied Mathematics, Moscow). Usp. Fiz. Nauk; 105: No. 1, 41-96(Sep 1971). (In Russian).

This intensive review article treats the several regions of the electromagnetic spectrum: rf, ir, optical, uv, x, and γ radiation. The radiation background of the Universe and energy of the Galaxy and of the Universe are discussed. Sources such as quasars, nebulae, and intergalactic gas (bremsstrahlung) are considered. Various models, isotropy, the Compton mechanism, and similar theoretical aspects are reviewed. (218 references) (K.S.W.)

10003 CHARGED-PARTICLE CREATION IN COSMOLOGY. Davies, P. C. W. (Cambridge Univ., Eng.). Nuovo Cim.; 6B: No. 2, 164-78(11 Dec 1971).

Three modifications of Maxwell's equations are discussed, which allow for the possibility of nonconservation of electric charge. The first, which arises from Wheeler–Feynman theory, is shown to lead to the excitation of negative-energy modes in the electromagnetic field, but does not satisfy the steady-state condition for a Lyttleton–Bondi universe. The second, constructed by Lyttleton and Bondi especially for their cosmology, does not excite the negative-energy modes. The third, due to Watson, is shown to be physically uninteresting. (auth)

10004 ARE THE ASTROPHYSICAL AND STATISTICAL SCHOOLS OF IRREVERSIBILITY COMPATIBLE? Gal-Or, B. (Israel Inst. of Tech., Haifa). Nature (London); 234: No. 5326, 217-18(26 Nov 1971).

The astrophysical school of thought maintains that the origin of irreversibility and all time asymmetrics observed in nature can be traced back to initial conditions that gave rise to the present expansion of the Universe as a whole, in serious contradiction to the more established statistical school which claims that irreversibility and time asymmetrics originated in the nature of macroscopic observations, that is, in the macroscopic instrument that records information and maintains a record of it. In the discussion presented an attempt is made to show that these schools of thought are essentially compatible, particularly from a cosmological viewpoint of entropy-free thermodynamics. It is first stressed that the introduction of statistics into the time-symmetric laws of classical or quantal mechanics does not by itself produce irreversibility. Secondly, some broad aspects of the Hogarth–Gold–Narlikar–Gal–Or school of thought are referred to, which explains how the first cosmological asymmetry is linked, in a one-to-one fashion to all other time asymmetrics in evidence. The theory postulated allows the construction of an entirely new and entropy-free thermodynamics in a close analogy to extant entropy-based nonequilibrium phenomenological or statistical theories. (UK)

10005 ROTATION DOES NOT ENHANCE MIXING IN THE MIXMASTER UNIVERSE. Matzner, Richard A. (Univ. of Texas, Austin); Chitre, D. M. Commun. Math. Phys.; 22: No. 3, 173-89 (1971).

Closed rotating cosmologies were investigated to determine if rotation leads to an enhancement of causal mixing proposed by Misner to guarantee the homogeneity of such models. It was concluded that rotation cannot lead to significantly more efficient mixing than occurs in nonrotating models. Since arguments presented by Doroshkevich and Novikov and calculations made by Chitre give very small probability of mixing in nonrotating models, it was therefore concluded that a plausible explanation of the homogeneity of the Universe cannot be found within the framework of classical general relativity. Such an explanation may lie in quantum effects on mixing near the singularity. (auth)

10006 STABILITY OF THE TAUB UNIVERSE. Bonanos, S. (Univ. of Chicago). Commun. Math. Phys.; 22: No. 3, 190-222 (1971).

An analysis of the stability of the Taub universe for arbitrary, initially small perturbations was carried out. It was found that the perturbations decrease during the expansion and increase during the contraction of the unperturbed space. In the process the general solution to a system of six coupled, linear, partial differential equations in six unknown functions of four variables was obtained. (auth)

10007 ONE SYSTEM OF EQUATION OF THE FOURTH ORDER COSMOGONY. Skorobogat'ko, V. Ya. (Physical-Mechanical Inst., Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 9, 787-90(Sep 1971). (In Ukrainian).

A system of fourth-order partial differential equations of the gravitational theory is shown. The known solutions of Einstein's

cylindrical world and de Sitter's spherical one are its solution, in particular. Geodetic lines in the theory are determined by four points. The systems of differential equations possess a property of nonlinear commutation. (auth)

10008 QUASI-STELLAR OBJECTS AND GRAVITATIONAL LENSES. Sanitt, N. (Cambridge Univ., Eng.). Nature (London); 234: No. 5326, 199-203(26 Nov 1971).

The space density of gravitational lens images as a function of redshift (z) is calculated for various cosmological models. Not all QSOs can be interpreted as gravitational lens images, unless there is a substantial amount of evolution with z in the sources of the lens images, and also a large fraction of the mass of the Universe is in the form of compact dark objects. A conservative estimate, assuming no evolution of the sources, and a smoothed-out density of 7×10^{-31} g/cm^{-3}, for the objects which act as lenses, results in a discrepancy by a factor $\sim 10^4$ between the comoving density of lens images and QSOs, out to a redshift of $z \simeq 2.8$. (auth)

10009 CP AND CPT SYMMETRY VIOLATIONS, ENTROPY, AND THE EXPANDING UNIVERSE. Ne'eman, Yuval (Tel-Aviv Univ., Israel). Int. J. Theor. Phys.; 3: No. 1, 1-5(Feb 1970).

The conjecture linking together statistical and cosmological time arrows implies interpreting the contracting phase in an oscillating cosmological model as a time-inverted expansion. The Fitch–Cronin effect now requires a redefinition of which is matter and which is antimatter in this time-inverted picture. However, if CPT is also broken, then the T-violating effects yield a different set of laws altogether for such reactions. (auth)

10010 TWISTING NULL CONGRUENCES IN ASYMPTOTICALLY FLAT SPACE. Aronson, Barry Allen. Pittsburgh; Univ. of Pittsburgh (1971). 70p. University Microfilms Order No. 72-2045.

Thesis.

The study of spinning particles in general relativity has been facilitated by the use of two particular types of coordinate systems. Type-I coordinate systems are based on congruences of null geodesics that are hypersurface orthogonal; i.e., shearing but not twisting, while Type-II coordinate systems are based on congruences of null geodesics that are asymptotically shear free but, in general, twisting. Asymptotic solutions to the NP equations in each type of coordinate system are investigated, and the coordinate and tetrad transformation between them is found. This transformation is used to relate the physical variables of the solutions in the Type-I and Type-II coordinate systems. (Diss. Abstr. Int., B)

10011 CLASSICAL DISTRIBUTIONS OF CHARGED DUST. Datta, A. K. (Bangabasi Coll., Calcutta). Indian J. Phys.; 44: No. 5, 278-82(May 1970).

The equations of classical hydrodynamics and electromagnetism for distribution of charged dust are considered. Some general theorems and formulae are obtained. (auth)

Planetary Phenomena

Refer also to abstracts 10185 and 10919.

10012 MOON: ITS ORIGIN AND PHYSIOGRAPHY. Mukerjee, Sudershan (National Atlas Organisation, Calcutta). Sci. Cult. (Calcutta); 37: No. 5, 230-6(May 1971).

The three hypotheses concerning the origin of the Moon are discussed in some detail, and the physical features of the lunar surface are briefly described. (W.D.M.)

10013 MOON: POSSIBLE NATURE OF THE BODY THAT PRODUCED THE IMBRIAN BASIN, FROM THE COMPOSITION OF APOLLO 14 SAMPLES. Ganapathy, R.; Laul, J. C.; Morgan, J. W.; Anders, E. (Univ. of Chicago). Contract AT(11-1)-382. Science; 175: No. 4017, 55-9(7 Jan 1972).

Soils from the Apollo 14 site contain nearly three times as much meteoritic material as soils from the Apollo 11, Apollo 12, and Luna 16 sites. Part of this material consists of the ubiquitous micrometeorite component, of primitive (carbonaceous-chondrite-like) composition. The remainder, seen most conspicuously in coarse glass and norite fragments, has a decidedly fractionated composition, with volatile elements less than one-tenth as abundant as siderophiles. This material seems to be debris of the Cyprus-sized planetesimal that produced the Imbrian basin. Compositionally this planetesimal has no exact counterpart among known meteorite classes, though group IVA irons come close. It also resembles the initial composition of the Earth as postulated by the two-component model. Apparently the Imbrian planetesimal was an Earth satellite swept up by the moon during tidal recession or capture, or an asteroid deflected by Mars into terrestrial space. (auth)

10014 CHONDRULES IN APOLLO 14 SAMPLES: IMPLICATIONS FOR THE ORIGIN OF CHONDRITIC METEORITES. King, Elbert A. Jr.; Carman, Max F.; Butler, John C. (Univ. of Houston, Tex.). Science; 175: No. 4017, 59-60(7 Jan 1972).

Chondrules were observed in several breccia samples returned by the Apollo 14 mission. These lunar chondrules are believed to have formed during a large-impact event, perhaps the one that formed the Imbrian Basin. This suggests that some meteoritic chondrules are also formed by impact processes such as crystallization after shock melting and abrasion and diffusion in base-surge and fall-back deposits generated by impacts on planetary surfaces. (auth)

10015 ORIGIN OF EXCESS ^{131}Xe IN LUNAR ROCKS. Eberhardt, P.; Geiss, J.; Graf, H. (Univ., Bern). Earth Planet. Sci. Lett.; 12: No. 3, 260-2(Nov 1971).

A barium feldspar sample was irradiated in a reactor with epithermal (>0.4 eV) and fast neutrons. A large amount of excess ^{131}Xe was found in the irradiated feldspar. A discussion of the possible neutron-induced reactions on Ba leading to ^{131}Xe shows that only resonance capture can be of importance. This experiment confirms the conclusion that epithermal neutron capture by ^{130}Ba is responsible for the large and variable $^{131}Xe_{ep}$ yield observed in lunar rocks. (auth)

10016 NOBLE GAS ANALYSIS OF KREEP FRAGMENTS IN LUNAR SOIL 12033 AND 12070. Funkhouser, J. (Max-Planck Institut fuer Kernphysik, Heidelberg). Earth Planet. Sci. Lett.; 12: No. 3, 263-72(Nov 1971).

Solar-wind noble gases of bulk Apollo 12 soil samples are related to the percentage KREEP component. The source material of KREEP had a prior solar-wind irradiation, the products of which were largely outgassed during deposition. Noble-gas analysis of individual KREEP fragments from 12033 and 12070, coupled with pertinent chemical data, enable specific events that have occurred at the Apollo 12 landing site to be dated. The age of Surveyor Crater is estimated to be about 240 my, while the original KREEP stratum was deposited at least 2 billion years ago. (auth)

10017 Li, Be, AND B ABUNDANCES IN FINES FROM THE APOLLO 11, APOLLO 12, APOLLO 14, AND LUNA 16 MISSIONS. Eugster, O. (CNRS, Orsay, France). Earth Planet Sci. Lett.; 12: No. 3, 273-81(Nov 1971).

The concentrations of Li, Be, and B were determined in the Apollo fine samples 10084, 12070, 14141, and 14259 and in a sample of the core tube returned by the automatic probe Luna 16. The abundance patterns of Li, Be, and B in the different soil samples are remarkably similar although the concentrations vary by a factor of four to eight being lowest in the Luna 16 sample and highest in the fines from Apollo 14. A strong correlation of Li, B, and K was found for the soil samples collected at the four sites. Within larger experimental errors Be is also correlated with these elements. Lunar abundances of Li, Be, and B are in good agreement with those in the terrestrial standard basalt BCR-1. Relative to basaltic achondrites and, in particular, relative to chondrites, lunar Li, Be, and B are enriched by a factor of up to 100. The Li, Be, and B concentrations in the Apollo 12 fines are enriched by factors of three to five relative to the average concentrations reported for the Apollo 12 basalts. This enrichment most probably is caused by the same additional component in the fines which is responsible for the three to four-fold excess of K, rare earth elements, and P (KREEP) relative to the basalts returned from the Ocean of Storms. It is shown that the fines from Apollo 12 and 14 can be related to each other by a two-component mixing model, one end member being the Apollo 12 basalts, the other one the fine sample 14141 whose chemical composition seems very similar to that of the KREEP component. (auth)

Atomic and Molecular Physics

Refer also to abstract 10902.

10018 (ORNL-4706, pp 183-252) CHEMICAL PHYSICS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

BARIUM NITRATES—crystal structure of, infrared and Raman spectral data on

BERYLLIUM FLUORIDES—BeF_2–LiF, x-ray-diffraction study of, atom-pair correlation functions from

BROMINE—reactions with cesium and potassium atoms of molecular, yield and energy of alkali ions from, (E)

CADMIUM NITRATES—Raman spectrum of anhydrous, at 77°K
CALCIUM NITRATES—Raman spectra of anhydrous, at 77, 200, 300°K
CESIUM—reactions of atoms of, with molecular bromine, chlorine, and oxygen, yield and energy of Cs^+ ions from, (E)
CHLORINE—reactions with cesium and potassium atoms of molecular, yield and energy of alkali ions from, (E)
GALLIUM—diffraction patterns of liquid, at 20°C, comparison of neutron and x-ray
IODINE IONS—reactions with targets (Z = 6 to 82) at 15 to 60 MeV, L x-ray spectra of iodine from, (E)
LITHIUM CHLORIDES—x-ray-diffraction data at 25°C of aqueous solutions of, correlation functions for
LITHIUM FLUORIDES—BeF_2–LiF, x-ray-diffraction study of, atom-pair correlation functions from
LITHIUM NITRATES—infrared emission spectra at 500°C by Fourier transform spectroscopy
—$KClO_3$–$LiNO_3$, infrared emission spectra at 500°C by Fourier transform spectroscopy
METALS—structure of liquid, solution of integral equation in mean spherical model for
METHANE—radiolysis by 100-eV-electron bombardment in electric field source
NITROGEN—excitation of molecular, K Auger spectrum from x-ray, (E)
NICKEL—neutron-diffraction pattern of polycrystalline
OXYGEN—reactions with cesium and potassium atoms of molecular, yield and energy of alkali ions from, (E)
POTASSIUM—reactions of atoms of, with molecular bromine, chlorine, and oxygen, yield and energy of K^+ ions from, (E)
POTASSIUM CHLORATES—infrared emission spectra at 500°C by Fourier transform spectroscopy
—$KClO_3$–$LiNO_3$, infrared emission spectra at 500°C by Fourier transform spectroscopy
POTASSIUM ACID CARBONATES—radiation effects at 77°K on single-crystal, EPR study of γ-
TRANSITION METALS—compounds of, chemical bonding of, photoelectron spectral study of multiplet splitting in
WATER—x-ray scattering data on, molecular correlation functions from
—spectra near 254°C in 0.85- to 1.3-μ region, effect of density and state on infrared-absorption
ZINC NITRATES—Raman spectrum of anhydrous, at 77°K (L.M.T.)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 10314.

10019 (BNL–50310, pp 35-41) FRESH LOOK INTO A PLASMA DYNAMICS. Majumdar, N. K. (Saha Inst. of Nuclear Physics, Calcutta (India)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

For a given gaseous system under a given potential difference, Poisson's equation of space charge is solved and spatial potentials are obtained, by-passing conditions that would lead to divergence. The results yield certain simple equations under assumption of cylindrical symmetry. These are utilized to investigate the interrelations between potentials and space charges that would tend to instability unless limited by the existing boundary conditions. When stability occurs at a certain state of sustained discharge it is possible to predict potentials at different parts of the system in terms of the geometrical and boundary parameters. This treatment extracts certain information that needs to be available to an ion source designer for critically assessing his ion source performance. (auth)

10020 (CONF-711021–4) EQUILIBRIUM CHARGE STATES OF FAST HEAVY IONS. Moak, C. D. (Oak Ridge National Lab., Tenn.). [1971]. 6p. Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

Measurements of equilibrium charge distributions for a wide variety of ions are being reported frequently in current literature. These measurements have improved the accuracy of various interpolations for velocity or ion species that may be needed in accelerator design or in planning experiments. Certain major effects and several minor ones have been identified, and these must be considered in making such estimates. The relative importance of some of the factors affecting equilibrium distributions are discussed. (auth)

10021 (CONF-711021–7) MICROWAVE HEATED PLASMA (ELMO) AS A SOURCE OF MULTIPLY CHARGED IONS. van der Woude, A. (Oak Ridge National Lab., Tenn.). [1972]. 28p. Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

The ELMO device in which a large volume of high-energetic, high-density plasma is created by microwave heating in a magnetic mirror is briefly described. The conditions in ELMO are such that single impact is the dominant process at least for the higher charge states. Relevant single-impact cross sections are reviewed. Some experimental results for multiply charged heavy ions are discussed. (M.O.W.)

10022 (LYCEN–7144) STUDY OF THE PLACES WHERE IONS ARE CREATED IN A PENNING SOURCE AS A FUNCTION OF THE SHAPE OF THE MAGNETIC FIELD USING A MONTE CARLO METHOD. Hadinger, Gerold (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 73p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A method of calculation was developed for determining where the ions are generated inside a Reflex ion source, in order to select the most efficient shape for the inhomogenous magnetic field. Electrons injected into a xenon plasma near the cathode with an energy equal to 2000 eV, were considered. The elastic and inelastic collisions between the electrons and the Xe atoms and the Xe^{+1} ions were studied. A Monte Carlo method was used to determine the mean free path between the collisions, the nature of the target, the nature of the collisions, and the scattering angles. The variation in the number of inelastic collisions as a function of the z coordinate gives information on the number of ions created and their location. The results obtained with this formalism show that for a constant magnetic field, ions are uniformly created along the Oz axis inside the source. For an inhomogenous magnetic field derived from a vector potential, which is maximum at the center of the source and minimum at the cathodes, the number of ions created is minimum at the center and maximum at the cathodes. This formalism can be applied for determining the ion density produced in a given source and the evolution with time of the concentration in a given element of volume. (France)

10023 (NP–19084) EFFECT OF SAMPLING CONDITIONS OF AN ION SOURCE ON THE PHASE–DENSITY DISTRIBUTIONS IN THE INTENSITY OF THE ION BEAM. Abroyan, M. A.; Kuznetsov, V. S.; Kuznetsova, N. P.; Fidel'skaya, R. P. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The phase density distribution for the beam section close to a source was measured. Ion beams obtained from a duoplasmatron were studied at different operating regimes of the source, i.e., at variation of extraction conditions. The calculated distribution of phase density near the source makes it possible to judge about the shape of the plasma boundary, dimensions of the radiating surface, and their variation with variation of extraction conditions. The results on the beam velocity structure near the source for different extraction conditions are given. (auth)

10024 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 6, NO. 10, 1971. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 69p.

This listing contains 261 references on various aspects of surface and vacuum physics. (M.O.W.)

10025 IMPROVEMENTS IN OR RELATING TO ELECTRON GUNS. McCann, John David (to United Kingdom Atomic Energy Authority). British Patent 1,251,333. 27 Oct 1971. Filed 31 Oct 1967.

Reference is made to electron guns adapted to emit a linear or sheet-like electron beam through a window on to objects to be irradiated. The gun described has a tubular anode having an electron-permeable window, the walls of the anode defining an evacuable closed chamber. An electrode assembly in this chamber, together with the anode, defines two electron-accelerating sections. This assembly comprises an elongated electron emitter extending in a direction parallel to the anode, with a first electrode positioned between the emitter and the anode, and having an electron permeable portion of metallic mesh aligned with the anode window. The second electron-accelerating section is formed between the first electrode and the anode, and means are provided for maintaining the emitter negative with respect to the first electrode and for maintaining a dc voltage gradient between the emit-

ter and the first electrode, this arrangement generating an electron beam and controlling the beam current. Means are also provided for maintaining the first electrode negative with respect to the anode and for maintaining a dc voltage gradient between the first electrode and the anode higher than that between the first electrode and the emitter; the electrons are thereby accelerated from the first accelerating section. The metallic mesh portion of the first electrode serves to reduce penetration of the electric field of the second accelerating section into the first. Various alternative electrode designs are described. A third electrode may also be provided between the emitter and the electron-permeable portion of the first electrode, and further electrodes may also be added. The emitter may be ac- or dc-heated. (UK)

10026 ANGULAR AND ENERGY DISTRIBUTION OF ELECTRONS PRODUCED BY 200 TO 500 keV PROTONS IN GASES. II. NITROGEN. Stolterfoht, N. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Phys.; 248: No. 1, 92-100(1971).

Absolute cross sections, differential in angle and energy of secondary electrons produced by interaction of 200- to 500-keV protons with molecular nitrogen, were measured in a crossed-beam scattering chamber using an electrostatic 90° spectrometer. Electrons with energies of 1 to 1300 eV were detected for 14 different angles of ejection in the range of 20 to 150°. The K-shell Auger spectrum of nitrogen was measured with a resolution of 1.1%. Single differential cross sections and total cross sections for ionization were obtained by numerical integration of the measured curves. Comparisons are made with other experimental results and with theoretical treatments by the Born approximation in particular with respect to the slow electron data. The measured cross sections with 300-keV proton impact agree well with experimental results of Toburen and Crooks et al. at energies above about 50 and 30 eV, respectively, whereas significant differences are found at lower energies. (auth)

10027 BACKSCATTERING FROM CRYSTALS USING MOLECULAR HYDROGEN IONS. Caywood, J. M.; Tombrello, T. A.; Weaver, T. A. (California Inst. of Tech., Pasadena). Phys. Lett.; 37A: No. 4, 350-2(6 Dec 1971).

Backscattering spectra of H^+, H_2^+, and H_3^+ ions incident on Si with the same velocity were observed. Proton spectra from H^+ and H_2^+ ions are essentially the same, but the spectrum from H_3^+ ions is significantly different. (auth)

10028 ANOMALOUS BEHAVIOUR OF Zn UNDER METAL ION BOMBARDMENT. Smith, H. J. (National Physical Research Lab., Pretoria). Phys. Lett.; 37A: No. 4, 289-90(6 Dec 1971).

Polycrystalline Zn bombarded with 39-keV ions of Ni, Co, and Cu to high doses does not show the expected saturation effect. Measurements at low temperature indicate an unusual diffusion mechanism to be responsible. (auth)

10029 AUTOIONIZATION OF LITHIUM-LIKE PARTICLES IN A FAST ION BEAM TRAVERSING A THIN FILM. Dmitriev, I. S.; Teplova, Ya. A.; Nikolaev, V. S. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1359-70(Oct 1971). (In Russian).

Formation of auto-ionized metastable states $(1s2s2p)^4P_{\frac{1}{2},\frac{3}{2},\frac{5}{2}}$ produced in lithium-like ions of light elements on passage of the ion beam through matter is investigated. The excited ions were recorded on the basis of the spontaneous increase of charge in a charge-exchange chamber. The lifetimes of the $(1s2s2p)^4P_{\frac{5}{2}}$ metastable state are determined for ions with nuclear charges Z between 4 and 8. It is found that after passage of the ion beam through a thin celluloid film the relative number of particles in this state is 0.3 to 7% of the total number of lithium-like ions. The major mechanism of formation of such particles is considered, and it is found that for ion velocities $v < Zv_0$ electron capture by ions with $Z \geq 4$, in contrast to protons, occurs mainly in the excited state. (auth)

10030 ENERGY SPECTRA OF ELECTRONS EJECTED FROM THIN METALLIC TARGETS BY FISSION FRAGMENTS OR α PARTICLES. Agranovich, V. M.; Daukeev, D. K.; Lebedev, S. Ya.; Mikhlin, E. Ya. (Inst. of Spectroscopy, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1511-21(Oct 1971). (In Russian).

Results are presented of a study of electrons ejected by fission fragments or α particles passing through a thin gold film. Energy spectra of electrons emitted at various angles to the film surface in reflection and traversal experiments are obtained by the time-of-flight technique. It is shown that in the spectrum of electrons ejected by the fission fragments there are two groups of electrons, a slow (isotropic) group and a last (anisotropic) group. The Kapitza thermal spike model is employed to describe the shape of the slow-electron spectrum. (auth)

10031 REFLECTION COEFFICIENT OF keV HEAVY-ION BEAMS FROM SOLID TARGETS. Boettiger, J.; Davies, J. A.; Sigmund, P.; Winterbon, K. B. (Univ. of Aarhus, Denmark). Radiat. Eff.; 11: No. 2, 69-78(Nov 1971).

Measurements of the reflected fractions of sodium, potassium, and krypton ions impinging on polycrystalline silver and gold and amorphous germanium targets were made at medium keV energies. The reflected fraction depends strongly on mass ratio and weakly on energy. Previous calculations of ion reflection (based on random slowing-down by elastic collisions in an infinite medium) were extended. Corrections to the calculated values due to electronic stopping and surface effects were estimated. Agreement between measurements and calculations is satisfactory. (auth)

10032 RADIOTRACER TECHNIQUE FOR MEASURING THE REFLECTION OF HEAVY IONS (OF keV ENERGIES) FROM SOLID SURFACES. Boettiger, J.; Davies, J. A. (Univ. of Aarhus, Denmark). Radiat. Eff.; 11: No. 2, 61-7(Nov 1971).

A radiotracer technique for measuring the reflected fraction of heavy ions impinging at keV energies on solid surfaces is described. This technique consists essentially in measuring the distribution of radioactivity between the target and a cylindrical collector surrounding it. A series of experiments was performed to establish the reliability and the limits of the technique. (auth)

10033 VTORICHNO-EMISSIONNYE I STRUKTURNYE SVOISTVA TVERDYKH TEL. (Secondary-Emission and Structural Properties of Solids). Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). 210p.

Separate abstracts were prepared for 18 of the papers. (D.L.C.)

For abstracts of individual papers see: 9730, 9731, 9836, 10034–10046, 10314, and 10315.

10034 SECONDARY ION EMISSION FROM A TUNGSTEN–MOLYBDENUM ALLOY UNDER THE INFLUENCE OF SLOW IONS. Gruich, D. D.; Khamidova, Kh. M.; Ermakov, G. E.; Arifov, U. A. pp 3-6 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The secondary ion emission arising from a 50 : 50 W–Mo target irradiated with 15 to 500 eV Na^+ ions was studied and correlated with the structure and properties of the corresponding material. A characteristic break appeared on the emission/energy curve at 300 to 350 eV. This apparently arose from the fact that there was a tendency for the Mo atoms to accumulate near the surface so that, up to a certain energy of the incident ions, only the Mo atoms were struck by the latter, and the characteristics of W failed to appear. (Metals Abstr.)

10035 POTENTIAL EMISSION OF ELECTRONS FROM THE (110) AND (111) FACES OF A MOLYBDENUM SINGLE CRYSTAL UNDER ION BOMBARDMENT. Arifov, U. A.; Rakhimov, R. R.; Dzhurakulov, Kh. pp 11-17 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The potential emission of electrons from the (110) and (111) faces of a Mo single crystal was studied on irradiating the crystal with 0.2–1.2-keV He^+ and Ar^+ ions, the corresponding V/A curves being recorded by means of an automatic potentiometer. The potential-emission characteristics differed for different types of ions and also for different crystal faces; however, in all cases, the curves were characterized by two distinct sections, namely: a low-energy section in which the emission coefficient remained independent of the energy of the incident particle, and a high-energy section in which this parameter rose sharply as a result of kinetic electron emission. (Metals Abstr.)

10036 ELECTRON EMISSION OF THE (110) AND (111) FACES OF A MOLYBDENUM SINGLE CRYSTAL ON BOMBARDING WITH HELIUM AND ARGON IONS AND ATOMS. Arifov, U. A.; Rakhimov, R. R.; Dzhurakulov, Kh. pp 17-26 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The secondary electron emission coefficient and energy distribution characteristic of the (110) and (111) faces of a Mo single crystal were studied on irradiating the crystal with 0.2 to 5.0-keV He and Ar ions and neutral atoms. The difference between ion and atom irradiation lay in the fact that, on irradiating with atoms, only kinetic electron emission occurred, whereas on irradiating with ions this was accompanied by potential emission as well, which exhibited considerable anisotropy. In the range of energies studied, the kinetic emission was approximately the same for both ions and atoms; however, the energy spectrum of the potential emission varied with ion velocity owing to a displacement in the energy levels of the ions when close to the surface of the metal. (Metals Abstr.)

10037 NEGATIVE-ION SPUTTERING OF SILVER BOMBARDED WITH CESIUM IONS. Abdullaev, M. K.; Ayukhanov, A. Kh. pp 26-30 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The emission of negative Ag ions from an Ag target irradiated with Cs^+ ions was studied by a mass-analyzer method. Strong and well-resolved (107) and (109) Ag peaks were obtained. No Ag-containing ions apart from Ag^- appeared. The number of Ag^- ions sputtered in this manner increased linearly with increasing energy of the incident ions. These and other associated results clearly indicated that the observed particles were essentially of a sputtering origin rather than constituting fragments of molecular compounds formed on the Ag surfaces. (Metals Abstr.)

10038 NEGATIVE-ION SPUTTERING OF TUNGSTEN BOMBARDED WITH ALKALI-METAL IONS. Shustrov, V. A.; Ayukhanov, A. Kh. pp 30-8 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The negative-ion sputtering of a polycrystalline W foil by incident Cs^+ ions was studied by a radioisotope method, a fair proportion of the ^{185}W isotope being incorporated in the target. The amount of material sputtered was directly related to the radioactivity of the material collected, the latter being calibrated by experiments with standard samples. For primary energies of 1 keV, approximately half the ejected particles constituted negative ions of W–O compounds derived from adsorbed O. The overall sputtering coefficient was almost independent of the incident-ion c.d. (Metals Abstr.)

10039 SECONDARY ELECTRON EMISSION FROM SURFACE OF GERMANIUM AND SILICON ON IRRADIATING WITH ALKALI IONS. Turmashev, E.; Ayukhanov, A. Kh. pp 38-41 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The secondary electron emission arising from the surface of Ge and Si crystals on irradiating with alkali metal ions was studied in relation to the mass and velocity of the incident ions. In each case, the maximum values of the secondary-emission coefficient were obtained when the mass of the incident ions was similar to that of the target atoms. However, the relation between the secondary electron-emission coefficient and the velocity of the incident ions was comparatively complicated, the energy transferred from one particle to another in a single collision being by no means the only factor determining this relationship. Possible reasons for the complexity of the interrelation are considered. (Metals Abstr.)

10040 SECONDARY EMISSION OF NEGATIVE PARTICLES FROM NICKEL–CHROMIUM AND COPPER–BERYLLIUM ALLOYS. Khadzhimukhamidov, Kh. Kh.; Makhmudov, A. Kh.; Ayukhanov, A. Kh. pp 41-5 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The secondary emission of negative particles (ions and electrons) from a range of Ni–Cr and Cu–Be alloys irradiated with 0.5- to 1.5-keV Na^+, K^+, and Cs^+ ions was studied, the secondary electrons being separated from the negative ions in a magnetic field with the V/A characteristics of the two types of particle being recorded on separate oscilloscopes. The slope of the secondary-emission coefficient/incident energy curves was greater for lighter than for heavier ions in all cases; for K^+ ions the coefficient passed to saturation at 0.9 keV after increasing with energy up to this point, while for Cs^+ the whole curve lay a little lower. In general, the secondary-emission behavior of the alloys was similar to that of simple metals. (Metals Abstr.)

10041 SECONDARY ELECTRON EMISSION OF NICKEL–CHROMIUM AND ALUMINUM–BERYLLIUM ALLOYS. Arifov, U. A.; Khadzhimukhamedov, Kh. Kh.; Makhmudov, A. Kh. pp 45-50 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The secondary-electron emission of Ni–Cr and Al–Be alloy targets was studied after irradiation with 0.2 to 1.2-keV primary electrons, using the double-modulation method, and the results were compared with those characterizing the corresponding simple metals. The secondary-electron emission characteristics were also plotted for alloy targets previously irradiated with alkali ions or treated in the vapor of the corresponding alkali metals. Either form of treatment led to a sharp increase in the secondary-emission coefficient, for example, in the case of an Ni–Cr target irradiated with Na^+ ions, a sharp maximum appeared on the emission coefficient/energy curve at 500 eV. (Metals Abstr.)

10042 ISOTOPIC EFFECT IN THE KINETIC ION–ELECTRON EMISSION [OF A SILICON CRYSTAL]. pp 50-6 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The kinetic ion–electron characteristics of Si crystals irradiated with two different Ne isotopes (^{20}Ne and ^{22}Ne) were studied. The lighter isotope excited more electrons than the heavier isotope in the surface layers of the Si target, and the ion–electron emission coefficient correspondingly differed for the two types of irradiating particle. On increasing the incident ion velocity, some of the acts of ionization took place from well inside the target material and the electrons there excited were unable to escape from the Si. In this case the isotopic effect became negligible (the coefficient remained the same for both incident particles). (Metals Abstr.)

10043 ANGULAR DEPENDENCE OF ENERGY OF SECONDARY IONS ARISING FROM MOLYBDENUM SINGLE CRYSTAL. Arifov, U. A.; Aliev, A. A. pp 56-64 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The energies of the secondary ions arising from Mo single crystals as a result of one, two, or more collisions of primary (600-eV Rb^+) ions with the target surface were studied, using an electrostatic condenser as energy analyzer. The high-energy part of the spectrum exhibited peaks with energies greater than that of the ordinary single-scattering peak; these peaks were attributed to multiple collisions, and were of a similar nature to that of the energy peaks already known to arise from individual faces of W single crystals. The form of the secondary-emission characteristics is discussed in relation to the crystal structure of the Mo single crystals. (Metals Abstr.)

10044 SECONDARY ELECTRON EMISSION IN VARIOUS STATES [IN SOLID AND MOLTEN INDIUM]. Arifov, U. A.; Kasymov, A. Kh. pp 114-17 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The secondary electron emission of solid and molten In was studied after irradiation with 0- to 1000-eV primary electrons, and the results were interpreted in terms of the different structure and short-range ordering of the metal in the two states of aggregation. In the case of samples subjected to ordinary forms of purification, there was very little difference between the secondary-electron emission of the solid and molten material, although after holding under vacuum for long periods there was a tendency for that of the molten samples to rise. This change was attributed to the deposition of residual gas atoms. (Metals Abstr.)

10045 ENERGY DISTRIBUTION OF SECONDARY ELECTRONS [EMITTED FROM TITANIUM, IRON, AND NICKEL]. Arifov, U. A.; Kasymov, A. Kh. pp 117-23 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The energy distribution of the secondary electrons emitted from Fe, Ni, and Ti surfaces on irradiation with 0- to 500-eV primary electrons was studied and the results interpreted in terms of the structures of the metals and the adsorption of impurities on their surfaces. Failure to clean adsorbed impurities from the surfaces of the metals leads to a sharp change in emission characteristics, very few elastically reflected electrons appearing. After intensive cleaning, a number of sharp maxima appear in the spectra; some of these are attributable to Auger electrons (e.g., the maximum at 148 eV for Ni and 145 eV for Ti). (Metals Abstr.)

10046 EFFECT OF MULTIPLE SCATTERING AND THERMAL VIBRATIONS ON REFLECTION OF IONS FROM FACE OF [NICKEL] SINGLE CRYSTAL. Parilis, E. S.; Turaev, N. Yu.; Kivilis, V. M. pp 123-8 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The effect of multiple scattering and thermal lattice vibrations on the reflection of high-speed ions from the surface of a metallic single crystal is considered theoretically and compared with experimental data relating to the reflection of Ar^+ ions (30 keV energy) from a Ni target. The scattering amplitude in any particular direction varies considerably with the target temperature, which is in turn related to the amplitude of the lattice vibrations. A model tentatively explaining these relationships for a (110) chain of Ni atoms is presented; the model is based on the Firsov potential and allows for both elastic and inelastic scattering. (Metals Abstr.)

10047 MECHANISM OF ION SCATTERING BY CRYSTALS. Mashkova, E. S.; Molchanov, V. A.; Skripka, Yu. G. (Moscow

State Univ.). Dokl. Akad. Nauk SSSR; 198: No. 4, 809-12(1 Jun 1971). (In Russian).

A crystal of Cu was exposed to a beam of 30-keV argon ions and the following angles were measured: glance, azimuthal rotation of the target, polar angle of scattering, azimuthal angle of scattering, total scattering angle, and ion emission angle. The ion scattering intensity was not a simple function of the azimuthal rotation of the target but was conditioned by several other factors. The ion intensity reaching the analyzer, which was situated in the plane of incidence of the original ion beam, was measured as a function of the azimuthal rotation of the target. The processes that tend to shape the scattered beam are discussed. (K.S.W.)

10048 OPERATIONAL CHARACTERISTICS OF A RADIO-FREQUENCY ION SOURCE. Khan, Mustafa Yar; Khan, Saadat Ali (Government Coll., Lahore, West Pakistan). J. Phys., E (London); 5: No. 1, 76-80(Jan 1972).

An rf ion source yielding a hydrogen-ion current of up to 6 mA, consisting of 60 to 70% protons, was constructed. The ion current yield was studied as a function of the discharge parameter, i.e., the oscillator input power, gas pressure, magnetic field, extracting voltage and extracting-electrode geometry. The ion current yield was increased by about 50% by the application of an axial magnetic field at a discharge pressure of about 30 mtorr. Mean beam energies of about 250 eV above the extracting voltage up to 4000 V were observed. (auth)

Atomic and Molecular Properties

Refer also to abstracts 9975, 9990, 10105, 10943, 10945, and 10980.

10049 OPTICAL INVESTIGATION OF THE HYPERFINE STRUCTURE OF SOME La I-LINES AND INTERPRETATION OF THE MEASURED A-VALUES. Fischer, W.; Huehnermann, H.; Mandrek, K. (Univ., Marburg, Ger.). Z. Phys.; 248: No. 1, 53-60(1971). (In German).

Several La I transitions were investigated by means of optical interference spectroscopy. All A-values of the levels of the configuration 5d6s6p with J = $^9/_2$, $^7/_2$, and $^5/_2$ were measured. Applying sum rules, the one-electron a-value a_{6s}(5d6s6p) was derived. It is shown that a promising interpretation of the measured A-values cannot be done without properly considering core-polarization and configuration interaction with adjacent configurations. (auth)

10050 MEASUREMENTS OF THE THERMAL CONDUCTIVITY OF GASES. III. DATA FOR BINARY MIXTURES OF HELIUM AND ARGON WITH HYDROGEN ISOTOPES. Cauwenbergh, H.; Van Dael, W. (Univ. of Leuven, Heverlee, Belgium). Physica; 54: No. 3, 347-60(15 Sep 1971).

Measurements are reported on the composition dependence of the coefficient of thermal conductivity in the binary mixtures He–H_2, He–HD, D_2–He, Ar–H_2 and Ar–D_2 at 296.8°K. It is shown that the Hirschfelder–Eucken formula describes the results quite well: for the mixtures containing Ar, it underestimates λ by about 2%, which may be due to the first approximations applied in $[\lambda_{H\text{-}E}]_1$. For the He mixtures the λ_{exp} value is slightly overestimated: this leads to the conclusion that a translational-rotational energy transfer term is present which decreases the λ_{exp} to or even below the $[\lambda_{H\text{-}E}]_1$. The results are consistent with the available data of the transition probabilities between the different energy modes. (auth)

10051 SHIFT IN A N.M.R. LINE OF ^{3}He RESULTING FROM METASTABILITY EXCHANGE COLLISIONS. Dupont-Roc, Jacques (Ecole Normale Superieure, Paris). Compt. Rend., Ser. B; 273: No. 6, 282-4(9 Aug 1971). (In French).

The various theories developed on the broadening and shift of the ground-state NMR line of ^{3}He, due to metastability exchange collisions with He atoms in the 2^3S1 state, are compared with experimental results. The treatment developed by the authors is the only one that explains the experimental results. (France)

10052 RELATIVISTIC CORRECTIONS TO THE HYPERFINE STRUCTURE OF THE ^{3}He ATOM. Labzovskii, L. N. Zh. Eksp. Teor. Fiz.; 61: No. 4, 1410-21(Oct 1971). (In Russian).

A complete calculation is carried out of the relativistic corrections of the order of α^2 to f, which is the ratio of the hyperfine splitting of the 2^3S_1 level of the ^{3}He atom to the splitting of the $2^2S_{1/2}$ level of the He^{3+} ion. The value obtained is $f_{theor} = 6.221153 \pm 0.000004$, whereas the experimental value is $f_{exp} = 6.2211384 \pm 0.0000012$. (auth)

10053 LONG-RANGE POLARIZABILITY OF THE HELIUM DIATOM. Certain, Phillip R.; Fortune, Patrick J. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 12, 5818-21 (15 Dec 1971).

The coefficients $A_6^{\parallel}$ and $A_6^{\perp}$ of R^{-6} in the long-range expansion of the helium diatom polarizability tensor were computed with the result $A_6^{\parallel} = 60.09$ a.u. and $A_6^{\perp} = 28.43$ a.u. (auth)

10054 EFFECT OF INTRA-ATOMIC ELECTRON CORRELATION ON DISPERSION FORCES USING DOUBLE PERTURBATION THEORY AND A ONE-CENTRE METHOD: APPLICATION TO He AND Li^+ INTERACTIONS. Singh, T. R. (Australian National Univ., Canberra). Chem. Phys. Lett.; 11: No. 5, 598-603(15 Nov 1971).

A one-center method is used to calculate the He–He, Li^+–Li^+ and He–Li^+ dispersion interactions through $O(R^{-10})$. The intra-atomic electron correlation contribution is calculated using double perturbation theory. A first step is to find the wave function corrected to first order in the interelectronic perturbation. (auth)

10055 MEASUREMENT OF THE HYPERFINE STRUCTURE OF THE $^3\Pi_u$ STATE OF H_2. Reno, Richard Wayne. New Haven; Yale Univ. (1971). 143p. University Microfilms Order No. 71-31,103.

Thesis.

The hyperfine structure of the N = 1 rotational state of some vibrational state of the $^3\Pi_u$ electronic state of H_2 was measured. This was done using a Rabi-type magnetic-resonance molecular-beams experiment. The theory of Jette and Cahill was found to give a good fit to the experimental data. Using this theory and the experimental values of the zero-field energy separations, experimental values were derived for the fine structure and hyperfine structure coupling constants. In addition to the values for the coupling constants, evidence is presented to show that nonadiabatic transitions occurred in the A and B magnets. Finally, evidence is presented to demonstrate that a transition in a different vibrational state has been observed. (Diss. Abstr. Int., B)

10056 STARK PROFILE MEASUREMENT FOR THE FIRST FOUR n-α LINES OF IONIZED HELIUM. Jones, Larry Addison. College Park, Md.; Univ. of Maryland (1971). 42p. University Microfilms Order No. 72-623.

Thesis.

Using an electromagnetically driven T-tube as a source, the profiles of the He II 304-Å (n = 2 to 1), He II 1640-Å (n = 3 to 2), He II 4686-Å (n = 4 to 3), and He II 10,123-Å (n = 5 to 4) lines were scanned and compared with Stark broadening theory. The plasma conditions correspond to electron temperatures from 4 to 5 eV and electron densities from 1×10^{17} cm^{-3} to 3×10^{17} cm^{-3}. Agreement of measured relative intensities with theory is typically within ~30%, provided a distinction is made between absorption and emission line shapes of the resonance line in a singly ionized helium plasma. (Diss. Abstr. Int., B)

10057 FORMATION OF ATOMIC IMAGES BY HIGH-ENERGY ELECTRONS. Bdulenko, A. P.; Vorobev, Yu. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 6, 621-3(Jun 1971).

Translated from Opt. Spektrosk.; 30: No. 6, 1164-9(Jun 1971).

A relativistic analysis of the formation in an electron microscope of an image of separate atoms or groups of atoms of different elements is given. The phase contrast of the image and the limiting resolving power of a high-voltage electron microscope are investigated. The dependencies of the contrast on the aperture of the objective, the defocusing, and the accelerating voltage are given, as is the dependence of the limiting resolving power on the accelerating voltage. The calculations are performed for electron energies of up to 10 MeV. (auth)

10058 OBSERVATION OF FINE STRUCTURE INTERFERENCE EFFECTS IN LYMAN-BETA RADIATION FROM BEAM–FOIL EXCITED HYDROGEN ATOMS. Lynch, Donald James. Corvallis, Oreg.; Oregon State Univ. (1972). 79p. University Microfilms Order No. 71-31,109.

Thesis.

Zero-field quantum beats were observed in Lyman–beta emission from hydrogen atoms formed by beam–foil excitation. The energy dependence of the magnetic substate relative cross sections for the n = 3, L = 1 states of H was determined for beam energies in the range from 230 to 500 keV per atom. The theoretical values of the fine structure energy splitting and the natural lifetime of the $3p_{1/2}$ and $3p_{3/2}$ states were verified. (Diss. Abstr. Int., B)

10059 SECOND-ORDER RAYLEIGH–SCHROEDINGER PERTURBATION ENERGY FOR HELIUM AND BERYLLIUM. Saxon, George Patrick. Waco, Tex.; Baylor Univ. (1971). 104p. University Microfilms Order No. 72-454.

Thesis.

The ground-state energies for helium and beryllium through second order were calculated by using Rayleigh–Schroedinger perturbation theory. The perturbation terms were the interelectronic potentials. The wave functions used were antisymmetric products of one-electron atomic eigenfunctions and were also eigenfunctions of spin. For helium the radial part of the positive

energy one-electron atomic eigenfunctions was obtained by solving the Schroedinger equation numerically. A type of box normalization was applied to these eigenfunctions. Calculations were performed for three different box sizes, and the energy was found to be a function of the size of the box. The energy was also obtained when the size of the box was extrapolated to infinity. Energies were also obtained when the positive energy eigenfunctions had the standard delta function normalization. The positive energy eigenfunctions were obtained for $0 \leq l \leq 4$. The total calculated energy through second order was $E_0 = -2.907212$ and differed from the experimental value by 0.12%. The second-order energy was $E_0^{(2)} = -0.157212$ and differed from that obtained by Knight and Scherr by 0.29%. Beryllium is Coulomb degenerate, and degenerate perturbation theory must be applied. The eigenvalues and eigenvectors of the first-order perturbation matrix were obtained. The true zero-order ground-state eigenfunction was then approximated and second-order energies were obtained. The approximation was the representation of the ground state by the state $1s^2 2s^2 {}^1S_0$. The total energy obtained through second order was $E_0 = -14.65885$, which is 0.06% above the experimental energy. (Diss. Abstr. Int., B)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 10311, 10564, 10987, and 10993.

10060 CARBONIUM ION AND POSITRONIUM QUENCHING BY DIAMAGNETIC ORGANIC MOLECULES. Shantarovich, V. P.; Petersen, K.; Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). Chem. Phys. Lett.; 11: No. 4, 464-5(1 Nov 1971).

Positronium was found to be highly sensitive to the presence of carbonium ions in the structures of diamagnetic organic molecules. This sensitivity is due to strong positronium quenching by the carbonium ion. (auth)

10061 MOBILITY OF POSITRONS IN SEMICONDUCTORS. Bergersen, B.; McMullen, T. (McMaster Univ., Hamilton, Ont.). Solid State Commun.; 9: No. 21, 1865-6(1 Nov 1971).

The utility of positron annihilation measurements of positron response to electric fields is discussed. The interpretation of such experiments using a deformation potential model is considered. (auth)

Collision Phenomena

Refer also to abstract 10904.

10062 (FRNC-TH-129) COLLISIONS OF IONS AND ATOMS OF RARE GASES AT MEDIUM ENERGIES (500 TO 3000 eV). Baudon, Jacques (Paris Univ., Orsay (France). Faculte des Sciences). 1969. 172p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Elastic and inelastic cross sections were measured at angles between 0.8 and 11 degrees (laboratory system) in the range 500 to 3000 eV for the He^+He, Ne^+Ne, Ar^+Ar, Kr^+Kr resonant collisions as well as for the following dissymmetric systems: He^+ with Ne, Ar, Kr, and Xe and Ne^+ with He. The elastic differential cross sections for the symmetric collisions present oscillations, which are simple for He, double for Ne, and more complex for Ar and Kr (semiclassical approximation from the potential curves corresponding to the ground state of the system). The reduced elastic cross sections present sharp drops for large values of the $E_0\theta$ product. This results from the opening of numerous inelastic channels in which the pseudo-crossing points of the potential curve play an important role. Simple excitation of the target atom is interpreted in terms of the two-state approximation. The violent collisions are interpreted in terms of the multiple crossings. (France)

10063 MODIFICATION OF THE ATTRACTION POTENTIAL IN THE BORN AND VAINSHTEIN APPROXIMATIONS USED IN THE QUANTIZED CALCULATION OF CROSS SECTIONS: DETERMINATION OF THE CORRESPONDING WAVE FUNCTION. Felden, Madeleine; Felden, Marceau (Univ., Nancy). Compt. Rend., Ser. B; 273: No. 16, 693-5(18 Oct 1971). (In French).

A modification of the potential is proposed in order to take into account a term neglected in the solution of the Schroedinger equation for an electron–atom system, the asymmetric shape of the wave function being unchanged. A screening effect is introduced for the nuclear charge. The corresponding wave functions are calculated. (auth)

10064 ANGULAR AND ENERGY DISTRIBUTION OF ELECTRONS PRODUCED BY 200 TO 500 keV PROTONS IN GASES. I. HELIUM. Stolterfoht, N. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Phys.; 248: No. 1, 81-91(1971).

The crossed-beam method was used to measure double differential ionization cross sections for electron production by 200- to 500-keV protons incident on a molecular beam. The ejected secondary electrons were detected by an electron multiplier and an electrostatic 90° spectrometer which was movable in the scattering chamber from 18 to 155° with respect to the incident-proton direction. After the elimination of disturbing electric and magnetic fields, electrons were measured at energies down to 1 eV. The absorption of the very slow electrons along their path through the spectrometer could be minimized by using a relatively low gas pressure in the scattering chamber of a few 10^{-5} torr. The efficiency of the electron detector was determined with an electron source whose emission rate per solid angle was known. Absolute cross sections and their angular dependence were obtained by measuring the slow electrons, ejected with a relatively high rate, without the molecular beam; these data were used to normalize the electron spectra acquired with the molecular beam. Ionization cross sections with 300-keV protons incident on helium are discussed and, except for the very slow electrons, a good agreement is found with results of Rudd et al. (auth)

10065 STATISTICAL MODEL FOR ION–MOLECULE REACTIONS. Fullerton, David Cleo. Atlanta; Georgia Inst. of Tech. (1971). 174p. University Microfilms Order No. 71-28,092.

Thesis.

Ion–molecule reactions are studied using a statistical phase-space model, and the theoretical predictions are compared with experimental results. The phase-space model assumes that a collision complex is formed between the interacting species, and the probability for a given process occurring is given as the phase space available to that process divided by the total phase space available for decomposition of the collision complex. In the basic form of the theory, decomposition of the complex is governed only by conservation of total energy and total angular momentum. These conservation principles determine the phase space available to a given product channel. Charge-transfer and dissociative charge-transfer reactions of rare gas ions with nitrogen are studied in the 0.05- to 200-eV energy range. Comparison between calculated and experimental cross sections for the charge-transfer processes indicates an incomplete mixing of statistically available N_2^+ product states. If experimental observation is used to select the dominant charge-transfer product state, qualitative agreement between calculated and experimental cross sections is obtained. Cross sections computed for endoergic dissociative channels of reaction are in good agreement with experiment. Cross sections for the collision-induced dissociation of O_2^+ and NO^+ ions were calculated as a function of reactant-ion kinetic energy. The mass-transfer reactions between C^+ and N_2 and O_2 to form CN^+ and CO^+, respectively, show that it is necessary to consider spin conservation in addition to conservation of energy and angular momentum in considering the products of ion–molecule reactions. Consideration of spin conservation for the above processes gives calculated cross sections that are in qualitative agreement with experimentally observed cross sections. Phase-space predictions for dissociative charge-transfer and charge-transfer processes are in agreement with experimental measurements at low ion kinetic energies. At high ion kinetic energies charge-transfer channels of reaction are more adequately described using a nearest resonance method. The phase-space model is shown to give product-ion internal-energy distributions consistent with experimental observations. The vibrational and rotational distributions of N_2^+ produced in charge-transfer reactions calculated using the phase-space model compare favorably with experimentally determined relative radiative intensities from product ions. In addition, kinetic energy distributions of the charge transfer and dissociative charge transfer show a good correlation with observed diatomic product-ion vibrational distributions. (Diss. Abstr. Int., B)

10066 COLLISION MECHANISM OF DISSOCIATIVE CHARGE-TRANSFER REACTIONS AT LOW ENERGY. Masson, Anthony John. Waltham, Mass.; Brandeis Univ. (1971). 498p. University Microfilms Order No. 71-29,418.

Thesis.

A new tandem mass spectrometer is described, consisting of a double-chamber ion source installed in a conventional mass spectrometer. A pulse method was developed for producing quasi-monoenergetic ion beams down to energies below 1 eV, and a pulsed time-of-flight technique was developed for giving limited, but crucial, mass analysis of the primary ion beam before it enters the reaction chamber. Energy analysis of both primary and secondary ions is carried out by the retarding potential method following their emergence from the reaction chamber.

A pulse method was developed for ejecting near-thermal product ions from the reaction chamber following transit of the reactant beam; the reactant ion energy is thereby unaffected, and the slow product ions, which would normally be unobserved, can then be mass- and energy-analyzed. The apparatus was tested by measuring the excitation function of the reaction $Ar^+ + D_2 \rightarrow ArD^+ + D$ in the energy range 1 to 100 eV; good agreement with existing data is obtained. The pulse technique for ejecting thermal product ions was tested using the reaction $Ar^+ + Ar \rightarrow Ar + Ar^+$ and found to be a reliable method for obtaining good lower limits for cross sections of charge-transfer reactions. The technique was also applied to a preliminary mechanistic study of the reaction $CD_4^+ + CD_4 \rightarrow CD_5^+ + CD_3$, and the occurrence of the D^+ stripping mechanism was directly demonstrated for the first time from the velocity distribution; the complex and D-atom stripping mechanisms are also observed, as in the results of other workers. The major application of these techniques has been to a mechanistic study of dissociative charge-transfer reactions at low energy. The reactions between Ar^+, Kr^+, and Xe^+ and methane were studied in the energy range 0.5 to 13 eV cms and found to occur by a resonant process over the whole energy range, in contrast to some existing preconceptions. It is shown that mechanistic deductions cannot be made from the shape of the excitation function, as is widely believed. On the other hand, some products with high kinetic energy are found in all cases, arising from encounters with impact parameters small enough to lead to collision; most encounters do not involve collision. This should be a general feature of charge-transfer processes, and one which has not generally been appreciated. An important finding is that in those cases where collision occurs the electron transfer occurs before collision, as the reactants approach; furthermore, where dissociation of the initial product is possible, this does not occur before the collision. Thus it is the initial products of the electron transfer that collide and undergo momentum transfer. A further finding is that when collision occurs the breakdown pattern of the product is modified by kinetic energy transfer. Thus on the one hand those products formed with thermal energy must come from encounters not involving collision, and show a breakdown pattern independent of the reactant kinetic energy; on the other hand those products formed with high kinetic energy must come from encounters involving collision and show a breakdown pattern strongly dependent upon the reactant kinetic energy. The energy transfer in these processes is discussed. The implications of these findings are discussed with reference to charge transfer in general, and the results of other workers. Several existing conceptions regarding low-energy asymmetric charge transfer are shown to be incorrect. (Diss. Abstr. Int., B)

10067 MEASUREMENT OF DIFFERENTIAL ATOMIC COLLISION CROSS SECTIONS. Fitzwilson, R. L.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Rev. Sci. Instrum.; 42: No. 12, 1864-9(Dec 1971).

An apparatus for the study of differential angular scattering of atomic projectiles by gas targets is described. The design facilitates system alignment and provides for accurate reproducible location of components. The performance of the instrument is studied for scattering of H^+ at 5 to 25 keV by helium and argon targets. Differential cross sections for elastic scattering and charge transfer are presented as well as total charge-transfer cross sections. The coefficients for secondary electron ejection by impact of H^0 and H^+ on a metal surface are compared. (auth)

10068 TECHNIQUE OF ION AND ELECTRON BEAM SUPERPOSITION FOR THE STUDY OF COLLISION PHENOMENA. Mahadevan, P.; Carpenter, H. C. (McDonnell Douglas Corp., Huntington Beach, Calif.). pp 8-13 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

The technique of ion and electron beam superposition is being used to study the fundamental collision phenomenon of ionization of ions by electrons. This involves the flight along identical linear paths of confined beams of electrons and heavier particles such as the positive ions of the atmospheric species. Design features of an electron gun that enables one to draw electrons from two offset, indirectly heated miniature cathodes into the axis of a long solenoid, are given. Other aspects discussed include the ion gun and focusing assembly and a computer-assisted electron-energy-scanning procedure for data acquisition. (auth)

10069 QUALITATIVE FEATURES OF GENERALIZED OSCILLATOR STRENGTHS AND IONIZATION CROSS SECTIONS IN ION–ATOM COLLISIONS. Nikolaev, V. S.; Kruglova, I. M. (Moscow State Univ.). Phys. Lett.; 37A: No. 4, 315-16(6 Dec 1971).

An exact expression is given for the squared modulus of the matrix element corresponding to the 3s electron transition into continuum states with zero energy. The qualitative features of generalized oscillator strengths and electron-loss cross sections for hydrogen-like ions in atomic collisions are considered. (auth)

10070 COLLISIONS BETWEEN ELECTRONS AND H_2^+ IONS. I. MEASUREMENTS OF CROSS SECTIONS FOR PROTON PRODUCTION. Peart, B.; Dolder, K. T. (Univ. of Newcastle upon Tyne, Eng.). J. Phys., B (London); 4: No. 11, 1496-1505(Nov 1971).

Cross sections were measured for the production of protons by collisions between electrons and H_2^+ ions for interaction energies between 18.4 and 980 eV. An ion source was specially designed to produce the H_2^+ ions under clearly defined conditions. At energies greater than 250 eV the present cross sections merge with those calculated by Peek (1967) in the limit of Born's approximation. This asymptotic behavior was not displayed by previous measurements. (auth)

10071 ASYMMETRY IN THE ANGULAR DISTRIBUTION OF THE FRAGMENTS PRODUCED FROM THE COLLISION-INDUCED DISSOCIATION OF HD^+ ION. Barua, A. K.; Saha, S.; Mullick, K. (Indian Association for the Cultivation of Science, Calcutta). J. Phys., B (London); 4: No. 11, 1450-7(Nov 1971).

An attempt was made to explain the recently observed asymmetry in the forward and backward scattering of the fragments produced from the collision-induced dissociation of heteronuclear molecular ions by considering their dipole moments. For simplicity, the electron impact dissociation of the HD^+ ion for the $1s\sigma^2\ ^1\Sigma_g^+ \rightarrow 2p\sigma^2\ ^1\Sigma_u^+$ transition was considered by applying the Born–Oppenheimer approximation. To include the effect of the dipole moment of the molecular ion, exchange scattering was also considered. The results show that contrary to the suggestion of some workers, the inclusion of the electron–dipole interaction term in the Hamiltonian cannot explain the observed asymmetries. This result should hold qualitatively for other heteronuclear molecular ions also. It is suggested that the asymmetry is due to the preferential orientation of the molecular ions due to the effect of the accelerating field on the dipole moment of the ions in the ion source chamber. (auth)

10072 EFFECT OF INACCURACY OF ATOMIC WAVE FUNCTION IN VARIATIONAL CALCULATIONS OF SCATTERING LENGTH. Peterkop, R.; Rabik, L. (Inst. of Physics, Riga). J. Phys., B (London); 4: No. 11, 1440-9(Nov 1971).

To investigate the error of the variationally calculated scattering length due to the inaccuracy of an atomic wave function, calculations were performed for positron and electron scattering by hydrogen atoms using an approximate atomic wave function. In the unmodified variant of calculation, the scattering length turns out to be sensitive to the change in the atomic wave function. If the number of correlation terms is large, a small error in the atomic wave function can cause a large error in the scattering length. The scattering length has a local maximum for a function near to the exact atomic wave function. Modified variants of calculation were considered in which the error in scattering length can be reduced. The connection with the correlation method was considered. The monotonicity theorem for Kohn's variational method was proved. (auth)

10073 IONIZATION OF POTASSIUM BY 20- TO 100-keV PROTONS. McCullough, R. W.; Gilbody, H. B. (Queen's Univ., Belfast). J. Phys., B (London); 4: No. 11, 1488-95 (Nov 1971).

A modulated crossed-beam technique was used to investigate the ionization of potassium by 20- to 100-keV protons. Absolute cross sections for electron production and cross sections for K^+ and K^{2+} formation were determined. The results are compared with recent calculations based on the classical impulse approximation and with experimental data on the ionization of potassium by electron impact. (auth)

10074 THREE-BODY IONIC RECOMBINATION AS A MARKOV PROCESS. Flannery, M. R. (Smithsonian Harvard Coll. Observatory and Astrophysical Observatory, Cambridge, Mass.). Ann. Phys. (N. Y.); 67: No. 2, 376-88(Oct 1971).

The description of ionic recombination as a Markov process is shown to yield the same equation for the quasi-equilibrium distribution of ion pairs among their bound states as that used by Bates and Flannery in their statistical theory of recombination. The description also permits a correlation between the previous approximate treatments, which regarded the recombination process as diffusion in energy space, and the formally and conceptually different treatment of Bates and Flannery. (auth)

10075 ROLE OF ATOMIC SPECTRUM IN MULTI-PHOTON IONIZATION PROCESSES. Kovarskii, V. A.; Perel'man, N. F. (Inst. of Applied Physics, Kishinev, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1389-98(Oct 1971). (In Russian).

The diagram series for the probability amplitude k_0 of photon ionization of an atom interacting with a strong electromagnetic wave is investigated. In the particular case of an atom with a hydrogen-like spectrum it is shown that a diagram with k_0 vertexes is the major diagram in the case of extremely weak fields; this corresponds to the usual perturbation theory. A diagram with a single vertex corresponding to the quasiclassical description is important in the region of strong fields and low frequencies. In the region of intermediate (with respect to the two cases just mentioned) field strengths the probability for multiphoton ionization of atoms can be satisfactorily described by a model involving transition via virtual levels strongly perturbed by the electromagnetic wave (diagrams with number of vertexes m, $1 < m < k_0$). Multiphoton ionization of neon atoms by the radiation from a neodymium laser is considered as an example. (auth)

10076 MOLECULAR COLLISIONS. XVI. COMPARISON OF GPS WITH CLASSICAL TRAJECTORY CALCULATIONS OF ROTATIONAL INELASTICITY FOR THE Ar–N_2 SYSTEM. Pattengill, M. D.; La Budde, R. A.; Bernstein, R. B.; Curtiss, C. F. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 12, 5517-22(15 Dec 1971).

The classical limit of the "infinite order" generalized phase shift (GPS) treatment of rotationally inelastic atom–molecule collisions was put into computationally feasible form in Paper XV of this series. It is now applied to a model problem intended to approximate thermal scattering of the Ar–N_2 system (collisional energy of $\frac{3}{2}$kT at 300°K), at the same time comparing its predictions with exact classical trajectory (CT) results. This comparison indicates that the present version of the GPS method over-estimates the rotational excitation and underestimates the de-excitation, while maintaining the total inelasticity at approximately the correct (CT) value. An approximate "quantization" of the classical results leads to an estimate of the quantal cross sections corresponding to changes by ±2, ±4, and ±6 from an initial rotor quantum state $\bar{l} = 10$. It is found that most of the total inelastic cross section (of some 32 Å^2) arises from the first-order-allowed transitions ($\Delta l = \pm 2$). (auth)

10077 CLASSICAL STUDY OF ROTATIONAL EXCITATION OF A RIGID ROTOR: $Li^+ + H_2$. La Budde, Robert A.; Bernstein, Richard B. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 12, 5499-5516(15 Dec 1971).

Classical calculations are presented for a model problem simulating the rotational excitation of H_2 (and D_2) in collision with Li^+, based upon the ab initio potential surface of Lester. The hydrogen molecule was taken to be a rigid rotor, even though this assumption becomes progressively worse as the collision energy is increased and the vibrational excitation threshold is crossed. However, the results should serve as a set of reference calculations on a well-defined system, suitable for comparison with semiclassical and quantal treatments. The influence of initial rotational state, molecular mass, and collision energy upon the angular distribution of the average rotational energy transfer and total inelasticity is evaluated and discussed. Most of the trends are due to simple dynamical effects, and they also occur in computations using a rigid ellipsoid model for the diatomic molecule. (auth)

10078 ION SCATTERING. II. RAINBOW EFFECT IN ELASTIC SCATTERING OF PROTONS BY HELIUM, NEON, AND XENON AND OF He^+ BY HELIUM. Weise, H.-P.; Mittmann, H.-U.; Ding, A.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 26a: No. 7, 1122-8(Jul 1971). (In German).

Differential scattering cross sections of H^+ on various noble gases and of He^+ on He were measured at various energies between 3 and 80 eV. The rainbow structure and the superimposed rapid oscillations were resolved. Differential cross sections were calculated in the WKB approximation and compared with experimentally obtained cross sections. Agreement was obtained by using the modified Morse potential. The fitting procedure discussed in part I was applied in order to obtain the parameters ϵ, r_m, G_1, and G_2. Calculations with the modified Lennard-Jones potential described in part I gave the same values for ϵ and r_m. With the exception of the system H^+–Xe, a single set of parameters could describe the rainbow structure and the fine structure at all ion energies. The values for ϵ and r_m agree fairly well with ab initio calculations. The reduced potentials have about the same shape, G_1 being between 2.7 and 2.2, G_2 being between 0.8 and 0.9. In the case of H^+–Xe, ϵ increases significantly with decreasing proton energy, while G_1 and G_2 have only slightly to be changed. The potential well is narrower than for the other systems mentioned above. These effects are attributed to the crossing of the potential curves of the systems H^+–Xe and H–Xe^+. (auth)

10079 ION SCATTERING. I. RAINBOW EFFECT IN ELASTIC SCATTERING OF PROTONS BY ARGON. Mittmann, H.-U.; Weise, H.-P.; Ding, A.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 26a: No. 7, 1112-21 (Jul 1971). (In German).

A crossed-beam apparatus for scattering experiments with ions on atoms or molecules is described. The results for the elastic scattering of H^+ on Ar are reported. Both the structure of the secondary rainbows and the superimposed fine structure were resolved. In order to fit the experimental curves, differential cross sections were calculated in the WKB approximation using three different reduced potentials. The fitting procedure and the influence of the chosen potentials on the resulting potential depth ϵ and the equilibrium distance r_m are described. Further, the information that can generally be obtained from the observed rainbows and the superimposed fine structure are discussed. For the system H^+–Ar the values $\epsilon = (4.04 \pm 0.1)$ eV and $r_m = (1.31 \pm 0.07)$ Å were obtained. These values are in good agreement with recent ab initio calculations of Roach and Kuntz. They are considerably different from those obtained by Champion et al., who did not observe the fine structure and used a too narrow potential in the evaluation of the scattering data. (auth)

10080 ELECTRON TRANSFER AND ION–ATOM INTERCHANGE IN C^+–CO COLLISIONS. Maher, K. E.; McClure, G. J.; Leventhal, J. J. (Univ. of Missouri, St. Louis). J. Chem. Phys.; 55: No. 12, 5549-50(15 Dec 1971).

Kinetic-energy distributions of CO^+ and C_2^+ ions resulting from C^+–CO collisions were measured over the incident-ion kinetic-energy range 13 to 30 eV. These distributions were used for calculation of the reaction energetics. The CO^+ kinetic-energy distributions provide strong evidence that this product is formed by both electron transfer and ion–atom interchange. In addition to the major (forward scattered) peak in the C_2^+ distribution, small yields of C_2^+ were detected at 180° in the center-of-mass system. (auth)

10081 DISSOCIATIVE EXCITATION OF VACUUM-ULTRAVIOLET EMISSION FEATURES BY ELECTRON IMPACT ON MOLECULAR GASES. II. N_2. Mumma, M. J.; Zipf, E. C. (Univ. of Pittsburgh). J. Chem. Phys.; 55: No. 12, 5582-8(15 Dec 1971).

Atomic-nitrogen multiplets that radiate in the vacuum ultraviolet were excited by electron impact on N_2. Their excitation cross sections were measured over the energy range from threshold to 350 eV. The transition arrays, mean wavelengths, and cross sections for dissociative excitation of these multiplets at 100 eV are: $N(2p^3\ ^4S^0 - 2p^2 3s^4\ ^4P)$ 1200 Å, 6.70×10^{-18} cm^2 ± 18%; $N[2p^3\ ^2D^0 - 2p^2(^1D)3s'\ ^2D]$ 1243 Å, 1.45×10^{-18} cm^2 ± 22%; and $N(2p^3\ ^2D^0 - 2p^2 3s\ ^2P)$ 1493 Å, 2.53×10^{-18} cm^2 ± 21%. In addition, the cross sections of the following multiplets were measured at 100 eV only: $N(2p^3\ ^2D^0 - 2p^2 4s\ ^2P)$ 1177 Å, 5.16×10^{-19} cm^2 ± 22%; $N(2p^3\ ^2D^0 - 2p^2 3d\ ^2D)$ 1164 Å, 1.63×10^{-19} cm^2 ± 23%. (auth)

10082 THEORY OF INELASTIC COLLISIONS: UNIFORM ASYMPTOTIC (WKB) SOLUTIONS AND SEMICLASSICAL S-MATRIX ELEMENTS FOR TWO-CHANNEL PROBLEMS. Eu, Byung Chan (McGill Univ., Montreal). J. Chem. Phys.; 55: No. 12, 5600-09(15 Dec 1971).

Semiclassical scattering matrix elements for two-channel problems are obtained by means of uniform asymptotic (WKB) solutions and solving a set of coupled first-order differential equations generated from the radial Schrödinger equations. By solving such first-order coupled equations, Stueckelberg's mathematically unsatisfactory procedure of tracing solutions in a complex plane to obtain the S-matrix elements is completely removed, and the expression thus obtained for the transition probability is devoid of physically unreasonable shortcomings of Stueckelberg's result. The S-matrix elements obtained are given in terms of well-defined quadratures easy to calculate and valid for any types of the interaction matrix elements, V_{ii} (x) and w (x). The transition probability obtained from the S-matrix elements is shown to reduce essentially to the well-known Landau–Zener expression as a limiting case when w (x) is small. (auth)

10083 EFFECT OF METASTABLE $O^+(^2D)$ ON REACTIONS OF O^+ WITH NITROGEN MOLECULES. Rutherford, J. A.; Vroom, D. A. (Gulf Radiation Tech., San Diego, Calif.). J. Chem. Phys.; 55: No. 12, 5622-4(15 Dec 1971).

Laboratory measurements indicate that the metastable ions of O^+ in reaction with N_2 in the low-energy range (14 eV) react to form principally N_2^+, while the ion–molecule reaction to form NO^+ has a very small probability. The ground-state O^+ ion reacts mainly to form NO^+. The abundance of metastable $O^+\ ^2D$ ions was determined using the observation that $O^+(^2D) + N_2$ has a small cross section for forming NO^+. The ion energy dependence for both reaction was measured within the energy range 1.0 to 500 eV. (auth)

10084 THEORY OF SEMICLASSICAL TRANSITION PROBABILITIES FOR INELASTIC AND REACTIVE COLLISIONS. II.

ASYMPTOTIC EVALUATION OF THE S MATRIX. Connor, J. N. L.; Marcus, R. A. (Univ. of Illinois, Urbana). J. Chem. Phys.; 55: No. 12, 5636-43(15 Dec 1971).

The asymptotic evaluation of the integral representation for an S-matrix element in a previously developed semiclassical theory of molecular collisions is considered. The integral representation is evaluated asymptotically by the method of Chester, Friedman, and Ursell to give a uniform approximation for the S-matrix element, which is valid for classically accessible and classically inaccessible transitions. The results unify and extend those previously derived, which were restricted to the simple semiclassical and Airy function cases. A comparison is made with the simple, Airy, and uniform semiclassical approximations that occur in Miller's semiclassical theory of molecular collisions. Although the starting point of the two theories is different, it is concluded that their asymptotic results are essentially identical. In addition, a simpler derivation of the integral representation for an S-matrix element from the semiclassical wave function is given, one which avoids the use of Green's theorem. (auth)

10085 SEMICLASSICAL TRANSITION PROBABILITIES (S MATRIX) OF VIBRATIONAL–TRANSLATIONAL ENERGY TRANSFER. Wong, W. H.; Marcus, R. A. (Univ. of Illinois, Urbana). J. Chem. Phys.; 55: No. 12, 5663-7(15 Dec 1971).

Uniformized coordinates and an integral expression for the semiclassical S matrix, derived elsewhere, are described and applied to vibrational transition probabilities. The expression obeys microscopic reversibility. The numerical results are compared with the exact quantum mechanical results of Secrest and Johnson. (auth)

10086 ELECTRON AFFINITIES FROM ENDOTHERMIC NEGATIVE-ION CHARGE-TRANSFER REACTIONS. II. O_2. Tiernan, T. O.; Hughes, B. M.; Lifshitz, C. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Chem. Phys.; 55: No. 12, 5692-5703(15 Dec 1971).

Electron-transfer reactions of negative ions were studied utilizing an in-line tandem mass spectrometer. Cross sections were measured as a function of translational energy for the reactions of D^-, O^-, S^-, SH^-, Cl^-, Br^-, and I^- with O_2. All of these reactions exhibit thresholds, their cross sections rising sharply with increasing energy above onset. The low-energy tails of the electron-transfer cross sections observed are shown to be caused by Doppler broadening of the effective center-of-mass energy, owing to the thermal motion of the target molecules. Center-of-mass energy distributions were calculated for several of the reactions (O^-, S^-, Br^-, and I^-) using an approximate one-dimensional treatment of the collisions. These energy distributions were convoluted with various trial threshold functions, and the calculated curves were fitted to the experimental cross sections to obtain the true energy thresholds. Within the limits of error of this method, thresholds derived for the various reactions yield a consistent lower limit for the electron affinity of O_2 of 0.45 ± 0.1 eV. (auth)

10087 INTERMOLECULAR POTENTIALS FROM CROSSED BEAM DIFFERENTIAL ELASTIC SCATTERING MEASUREMENTS. III. He + He AND Ne + Ne. Siska, P. E.; Parson, J. M.; Schafer, T. P.; Lee, Y. T. (Univ. of Chicago). J. Chem. Phys.; 55: No. 12, 5762-70(15 Dec 1971).

High-resolution differential cross sections for elastic scattering extending to wide scattering angles for He–He and Ne–Ne were measured at two collision energies in the thermal range. The experiments were carried out by crossing two supersonic nozzle atom beams at right angles and detecting the atoms scattered in the plane of the beams with a rotatable electron-bombardment mass-filter universal detector. The results are analyzed to yield information on the interatomic potentials for these systems using a realistic and flexible potential function, and comparison is made with previously proposed potentials. For He_2, a somewhat "harder" low-energy repulsion than that of most such potentials is inferred, while for Ne_2 the potential well depth found is ~30% larger than earlier estimates and in good agreement with a preliminary spectroscopic finding. (auth)

10088 SIMPLE ERROR BOUND FOR COUPLED-CHANNEL SCATTERING CALCULATIONS. Miller, W. H. (Univ. of California, Berkeley). Chem. Phys. Lett.; 11: No. 4, 535-8(1 Nov 1971).

Since the complete set of rotation–vibration states of a molecule contains a dissociative continuum, a coupled-channel calculation for molecular scattering parameters based on an expansion in the set of discrete molecular states does not give the correct values. Here it is shown how one can very simply obtain a rigorous bound to the contribution from all internal states—discrete and continuous—which are omitted in a finite coupled-channel calculation. (auth)

10089 FORMATION OF ENERGETIC PROTONS BY ELECTRON IMPACT ON METHANE. Appell, J.; Kubach, C. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 11: No. 4, 486-90 (1 Nov 1971).

By impact of low-energy electrons on CH_4, protons of high translational energy are produced. Evidence is given that they arise from the dissociation of the first excited state of CH_4^+, which results from the removal of the $2a_1$ electron from methane. (auth)

10090 MECHANISM OF THE REACTION $K + Br_2 \rightarrow K^+ + Br_2^-$ NEAR THE THRESHOLD. Zembekov, A. A. (Inst. of Chemical Physics, Moscow). Chem. Phys. Lett.; 11: No. 4, 415-6(1 Nov 1971).

Analysis of the possible mechanisms of the reaction $K + Br_2 \rightarrow K^+ + Br_2^-$ near the threshold is presented. It is assumed that the valence electron of an alkali atom is transferred to the halogen molecule at the intermolecular distance, depending upon the vertical electron affinity of the halogen molecule. Deactivation of the vibrationally excited Br_2^- ion occurs in the subsequent collision with the K^+ ion and this provides the possibility of the reaction under discussion. (auth)

10091 AMPLITUDES FOR SCATTERING OF ELECTRONS BY HYDROGENIC AND ALKALI-LIKE ATOMIC SYSTEMS. Moores, D. L. (University Coll., London). Comput. Phys. Commun.; 2: No. 6, 360-7(Oct-Nov 1971).

A computer program for calculating amplitudes for elastic and inelastic scattering of electrons by hydrogenic and alkali-like atomic systems from reactance matrix elements, assumed to be punched on cards in a standard format, is described. Data are sorted and checked and the summations required are performed. Transitions from the ground state to up to 3 final s states and up to 2 p states can be handled. Coupling to atomic states with $l < 3$ only is considered. Dimensions may be altered to increase the scope of the program. The program is written in FORTRAN IV for the IBM 360/65. (A.G.W.)

10092 COMPUTATION OF ENERGY DEPENDENT SCATTERING AMPLITUDES VIA ANALYTIC CONTINUATION OF THE FREDHOLM DETERMINANT. Murtaugh, T. S.; Reinhardt, W. P. (Harvard Univ., Cambridge, Mass.). Chem. Phys. Lett.; 11: No. 5, 562-7(15 Nov 1971).

A rapid method for calculating partial-wave scattering amplitudes over a range of energies is presented. Approximate values of the partial-wave Fredholm determinant are computed at a number of points in the complex energy plane from a single matrix tridiagonalization and are continued to the real axis via point-wise rational fraction analytic continuation. For two model problems accurate scattering information is obtained over a wide range of energies, and resonances are easily located by noting the zeros of the real part of the determinant. (auth)

10093 COLLISION-INDUCED DISSOCIATION: A SIMPLISTIC OPTICAL MODEL ANALYSIS. Levine, R. D.; Bernstein, R. B. (Univ. of Wisconsin, Madison). Chem. Phys. Lett.; 11: No. 5, 552-6(15 Nov 1971).

The cross section σ_{CID} for the collision-induced dissociation (CID) of a diatomic molecule (or ion) by atomic impact in the post-threshold energy region is found to be of the form $\sigma_{CID} \propto (E_{tot} - E_0)^{5/2}/E_{tr}$, where E_{tr} is the initial relative translational energy, E_{tot} the total (translational + internal) energy, and E_0 the endoergicity (or threshold energy). The power $5/2$ is a direct consequence of the 3-body final state of the CID process. (auth)

10094 TOTAL SCATTERING CROSS SECTION OF He–H_2 AT THERMAL ENERGIES. Grace, Robert Sutton. Tallahassee; Florida State Univ. (1971). 137p. University Microfilms Order No. 72-268.

Thesis.

Absolute helium–hydrogen-molecule total cross sections for thermal-energy collisions were measured using molecular beams derived from nozzle sources and crossed at right angles. Both nozzles were adjustable in temperature over limited ranges to provide variation in the relative velocities. The absolute density of the target gas (H_2) was measured with a capacitance manometer. The experimental cross sections, corrected for finite angular resolution, were compared to theoretical cross sections derived from quantum mechanical integration of the wave equation wherein spherically symmetric potential models were assumed. Over a relative velocity range of 2000 to 3000 m/sec the cross section was found to be nearly constant in magnitude averaging 48 Å^2. A spherical potential that best fits the experimental data (Lennard-Jones (12,6), ϵ = 0.7 MeV, r_m = 3.57 Å) was obtained for molecular separations of 2.7 to 3.3 Å. The results are consistent with previously reported theoretical and experimental works. (Diss. Abstr. Int., B)

10095 ENERGY EXCHANGE IN H_2 + He COLLISIONS. Brown, Nancy Jeanne Buccos. College Park, Md.; Univ. of Maryland (1971). 101p. University Microfilms Order No. 72-1680.

Thesis.

Collisions between a hydrogen molecule and a helium atom were studied using the quasi-classical approximation. The rotational relaxation time for the J = 0 to 2 rotational transition has been calculated at 196°K and 300°K. Comparison with experimental data was satisfactory. The dissociation of hydrogen by helium was studied at 5500°K. The reaction cross sections were very dependent on the initial quantum states of the molecule. Although agreement between theory and experiment is satisfactory, the calculation of the rate constant results in a value that is larger than the experimental value. (Diss. Abstr. Int., B)

10096 MEASUREMENT OF RELATIVE CROSS SECTIONS FOR SIMULTANEOUS IONIZATION AND EXCITATION OF THE HELIUM 4^2S AND 4^2P STATES. Sutton, John Franklin. Washington, D. C.; American Univ. (1971). 218p. University Microfilms Order No. 71-30,527.

Thesis.

The relative cross sections for simultaneous ionizations and excitation of helium by 200-eV electrons into the 4^2P and 4^2S states were measured by a fast delayed coincidence technique. Results are in poor agreement with Born approximation calculations for simultaneous ionization and excitation of helium, but show good agreement with the relative cross sections for single electron excitation of helium and hydrogen. This suggests that the double process may be thought of in terms of a sudden approximation where single electron excitation plays the dominant role and the second electron becomes ionized because of a sudden change in its effective nuclear charge. An application of the results of the measurement to the development of a uv intensity standard is suggested. This technique involves the use of known branching ratios, a visible light flux reference, and the measured relative cross sections. (Diss. Abstr. Int., B)

10097 EXPERIMENTAL CROSS SECTIONS FOR ELECTRON-IMPACT EXCITATION OF ATOMIC OXYGEN AND NITROGEN. Stone, Edward Johnson. Pittsburgh; Univ. of Pittsburgh (1971). 109p. University Microfilms Order No. 72-2145.

Thesis.

The absolute cross sections were measured for the excitation of aeronomically important transitions in electron impact on atomic oxygen and nitrogen. In atomic oxygen, the total absolute cross section for excitation of the resonance triplet at 1304 Å and the excitation function for the forbidden transition at 1356 Å were determined from threshold to 140 eV. In atomic nitrogen, total absolute cross sections for the excitation of the resonance transitions at 1134 Å and 1200 Å and for three minor transitions were measured over a comparable energy range. The technique involved passing an electron beam through a flow of gas that had been partly dissociated by passage through a microwave discharge. The resulting ultraviolet radiation was observed with a vacuum monochromator. The equilibrium atomic densities were determined by a resonance absorption technique. The absolute magnitudes of the cross sections were determined by comparison with known dissociative cross sections. The technique for calibration of the relative spectral response of the optical system was refined and extended so that now a highly accurate technique for calibrating vacuum ultraviolet instruments over the wavelength interval 1050 to 1800 Å exists. The measured cross sections were applied to the interpretation of the ultraviolet spectra of the day airglow, the polar aurora, the tropical ultraviolet airglow, and the question of the density of atomic nitrogen in the upper atmosphere. (Diss. Abstr. Int., B)

10098 ELECTRON–ATOM EXCITATION WITH SPIN ANALYSIS. Bederson, Benjamin (New York Univ., N. Y.). Comments At. Mol. Phys.; 2: No. 5, 160-4(Dec 1970-Jan 1971).

The use of polarized atomic beams in studying inelastic collisions with either polarized or unpolarized electrons is considered. The discussion is especially related to the recoil-type experiment, in which observation of the scattering event is made on the scattered atom, including observation of change of spin state as a result of the collision. Specifically the relation of the observables, i.e., certain partial cross sections, to the appropriate scattering amplitudes is shown using physical arguments based upon reasonable and quite general assumptions. (A.G.W.)

10099 EFFECTS OF RESONANCES ON THE ELECTRON-IMPACT BROADENING OF ION LINES. Griem, Hans R. (Univ. of Maryland, College Park). Comments At. Mol. Phys.; 2: No. 5, 147-50(Dec 1970-Jan 1971).

Three points are made in relation to Baranger's result (Phys. Rev., 112: 815(1958)) for the simplest case of an isolated line with negligible perturbations of the lower state. The first two points concern resonances in elastic electron–ion scattering to which the result is applicable and a possible method of avoiding difficulties due to resonances. Third, a replacement for Baranger's equation is suggested, and effects of this change on calculated widths and shifts are discussed briefly. (A.G.W.)

10100 THRESHOLD PHOTOIONIZATION OF THE MOLECULAR ION H_2^+ IN THE UNITED ATOM MODEL. Borisov, M. S.; Vetchinkin, S. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 3, 226-7(Mar 1971).

Translated from Opt. Spektrosk.; 30: No. 3, 409-12(Mar 1971).

The threshold photoionization of a model molecular system, H_2^+, is discussed, for a small distance R between the protons. The photoionization cross section was calculated in second-order perturbation theory to within terms of the order of R^4 ln R. (auth)

Atomic Theory

Refer also to abstracts 10202 and 10368.

10101 CORRELATION OF MOLECULAR ORIENTATION IN LIQUID WATER BY NEUTRON AND X-RAY SCATTERING. Page, D. I. (Atomic Energy Research Establishment, Harwell, Eng.); Powles, J. G. Mol. Phys.; 21: No. 5, 901-26(1971).

The neutron-diffraction structure factor for heavy water at 22°C was measured for momentum transfers, $\hbar Q$, up to a Q of 13 $Å^{-1}$. The results have been interpreted by abstracting the molecular structure effects, as far as possible, and using models for the correlation of orientation of pairs of molecules ranging from completely uncorrelated orientation to that for adjacent molecules in ice I. Neither these nor any of the popular models for the structure of water, nor a non-hydrogen bonded model, fit the neutron-diffraction data over the whole range of Q. Nevertheless, information about the molecular-centers structure factor is obtained, expecially for Q up to about 3 $Å^{-1}$. The method of analysis is generalized and applied to x-ray diffraction data and, in particular, to x-ray data for liquid water. It is shown that this method of analysis has some advantages over the conventional method. The effect of correlation of molecular orientation is less than that of molecular structure on x-ray scattering by water and rather more extensive information is obtained for the molecular-centers structure factor than from neutron data — if the conventional assumption of atomic electron clouds is accepted. A comparison of the x-ray and neutron scattering data for liquid heavy water shows that the two sets of data are reasonably consistent for any of the usual models for water, except for the region of Q between 3 and 5 $Å^{-1}$. The molecular-centers structure factor of water has a weak double humped first maximum with peaks at 2.0 and 2.9 $Å^{-1}$, probably followed by a damped oscillation. This contrasts with atomic liquids but is similar to that found in liquid carbon tetrachloride. The structure of liquid water is not, therefore, necessarily unique or unusual. (auth) (UK)

10102 ELECTRIC DIPOLE MOMENT OF MOVING MAGNETIC DIPOLE. Fisher, George P. (Univ. of Colorado, Boulder). Amer. J. Phys.; 39: No. 12, 1528-33(Dec 1971).

The fact that a magnetic dipole μ moving with velocity βc has an electric dipole moment $p = \beta \times \mu/c$ has made periodic appearance in the literature but the importance of this fact and its general utility have not been given sufficient expression. The equation $p = \beta \times \mu/c$ is derived and then used for a simple description of the atomic spin–orbit interaction. (auth)

10103 AUGER TRANSITION RATES IN j–j COUPLING FOR d-HOLES AND f-ELECTRONS. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Phys.; A172: No. 1, 127-38(1971).

Asaad's earlier calculations are supplemented by computing Auger transition rates in j–j coupling for initial d-shell holes and f-shell electrons. (auth)

10104 MUTUAL SPIN–ORBIT AND SPIN–SPIN INTERACTIONS IN ATOMIC STRUCTURE CALCULATIONS. Jones, M. (University Coll., London). J. Phys., B (London): 4: No. 11, 1422-39(Nov 1971).

A method of including the spin–spin and spin–other–orbit interactions of the Breit–Pauli hamiltonian in the calculation of bound states of atomic systems is described. It represents an extension of a program described recently, in which energy levels of complex atoms are calculated with relativistic corrections. The same powerful and versatile computing techniques are employed, and expressions for the spin–spin and mutual spin–orbit interactions are given in forms suitable for application of these techniques. Some illustrative numerical results

are given, showing that an appreciable improvement may be obtained by including these operators. In the case of Fe VI it is shown that more extensive nonrelativistic calculations including correlation effects will be necessary before wholly satisfactory calculations of fine structure are possible. (auth)

10105 ALGEBRAIC DETERMINATION OF ELECTRON–NUCLEAR AND ELECTRON–ELECTRON DISTRIBUTION FUNCTIONS FROM HYLLERAAS-TYPE WAVE FUNCTIONS. Benesch, R. (Univ. of Waterloo, Ont.). J. Phys., B (London): 4: No. 11, 1403-14(Nov 1971).

The radial electron–nuclear and electron–electron distribution functions, $D_0(r)$ and $P_0(r_{12})$, are evaluated by algebraic methods from 20-term Hylleraas-type wave functions describing the ^1S ground states of He and He-like ions. Expectation values of several one- and two-electron operators, including the one- and two-electron contributions to the potential energy, are very easily evaluated in terms of these distributions. Numerical values of the expansion coefficients a_n, b_n, c_n are reported for H^-, He, Li^+, B^{3+}, O^{6+}, Ne^{8+}, and Mg^{10+}. (auth)

10106 THEORY OF SEPARABILITY OF MANY-ELECTRON SYSTEMS. Huzinaga, S.; Cantu, A. A. (Univ. of Alberta, Edmonton). J. Chem. Phys.; 55: No. 12, 5543-9(15 Dec 1971).

Atomic and molecular systems are often intuitively separated into almost independent subsystems as, for example, the core and valence parts of an atom. Consequently, if this separation provides a good approximation, one can obtain the states of the system from the states of the subsystems that best represent the entire system. In the light of the work of McWeeny, in which one assumes strong orthogonality among subsystem wave functions, an effective Hamiltonian for a given subsystem that should properly describe the states of that subsystem is determined. Previous work is shown to have dealt with an improper effective Hamiltonian. (auth)

10107 ENERGY-MAXIMIZATION METHOD FOR AUTOIONIZING STATES. Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.); Drake, G. W. F. Chem. Phys. Lett.; 11: No. 4, 509-11(1 Nov 1971).

A method is proposed for the calculation of the positions of autoionizing resonances, in which the lowest eigenvalue of the hamiltonian matrix is maximized with respect to the position of a radial node in the trial wave function. The results are compared with more precise calculations for the $2s2p\ ^{1,3}P$ states of helium. (auth)

10108 DERIVATION OF THE EXTENDED HARTREE–FOCK EQUATIONS. Mayer, I. (Central Research Inst. for Chemistry, Budapest). Chem. Phys. Lett.; 11: No. 4, 397-400(1 Nov 1971).

The extended Hartree–Fock (EHF) equations of the spin-projected scheme are derived without the one-λ approximation used previously by Martino and Ladik. The derivation is based on the corresponding generalized Brillouin theorem. (auth)

10109 SEPARATION AND EVALUATION OF FIRST-ORDER-PERTURBATION INTERMOLECULAR-ENERGY TERMS IN LCAO MO SCF CALCULATIONS. APPLICATION TO THE He_2 SYSTEM. Beltran-Lopez, V. (Centro Nuclear de Mexico, Mexico City); Flores, M. Javier; Novaro, O. Chem. Phys. Lett.; 11: No. 4, 417-20(1 Nov 1971).

A technique is presented for the calculation of the complete first-order perturbation energy between molecules from an LCAO MO SCF calculation. The method permits also the evaluation of the individual first-order energy terms as obtained in a double expansion in the intermolecular potential and overlap integral. An application is made to the He_2 system at various internuclear distances. (auth)

10110 SELF-CONSISTENT RANDOM-PHASE APPROXIMATION. Ostlund, N.; Karplus, M. (Harvard Univ., Cambridge, Mass.). Chem. Phys. Lett.; 11: No. 4, 450-3(1 Nov 1971).

An analysis is made of the self-consistent random phase approximation (SC RPA) in which the ground-state function satisfies the annihilation condition. It is shown that the ground state for a two-electron system is identical with that obtained by a variational calculation including doubly excited configurations and that the excitation energies are the same as the Tamm–Dancoff values corrected for the ground-state correlation energy. To illustrate the iterative procedure by which the SC RPA solution is obtained, an application to H_2 is included. (auth)

10111 CLUSTER EXPANSION FOR THE ENERGY OF THE MANY-ELECTRON ATOM IN THE nTH ORDER OF THE PERTURBATION THEORY. Dmitriev, Yu. Yu.; Bochkariov, V. B.; Labzovskii, L. N.; Zashikhin, M. N. (Leningrad State Univ.). Chem. Phys. Lett.; 11: No. 5, 620-2(15 Nov 1971).

A cluster expansion for the nth-order correction to the energy of a many-electron atom is derived. A possible application to the calculation of the third-order correction to the energy is considered. (auth)

10112 USE OF COULOMB GREEN FUNCTIONS IN ATOMIC CALCULATIONS. II. THIRD-ORDER FEYNMAN DIAGRAMS FOR ENERGY. Ivanov, L. N.; Ivanova, E. P.; Safronova, U. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 3, 213-17(Mar 1971).

Translated from Opt. Spektrosk.; 30: No. 3, 385-93(Mar 1971).

Third-order diagrams for the energy of states with filled shells are discussed. The contributions of Hartree–Fock diagrams and correlation diagrams with Hartree–Fock inserts for the ground state of a two-electron system are calculated. The polarization diagrams are evaluated. A method is proposed for calculating these diagrams by using a two-body Coulomb Green function. (auth)

Cosmic Radiation

Refer also to abstracts 9366, 9373, 9375, 10395, 10396, and 10463.

10113 INTERSTELLAR PROPAGATION OF GALACTIC COSMIC-RAY NUCLEI $2 \leq Z \leq 8$ IN THE ENERGY RANGE 10 TO 1000 MeV PER NUCLEON. Mason, G. M. (Univ. of Chicago) Astrophys. J.; 171: No. 1, 139-61(1 Jan 1972).

The differential kinetic energy per nucleon spectra of galactic cosmic-ray He, Li, Be, B, C, N, and O was analyzed with the University of Chicago cosmic-ray telescope on board the IMP-5 satellite in 1969–1970. The ratios He/(C + N + O) and (Li + Be + B)/(C + N + O) obtained from these spectra were found, within errors of ~20%, to be energy independent over the energy range 10 to 1000 MeV per nucleon, and equal to ~15 and ~0.25, respectively. These results were compared with discrepancies existing among other measurements of these ratios, and with predictions of a class of steady-state models of cosmic-ray propagation which assume that Li, Be, and B are absent in cosmic-ray sources. The best fits for the present measurements were obtained for models with a source spectrum in the form of a power law in total energy per nucleon, but even these fits were outside the error limits at energies below 100 MeV per nucleon. In the context of the propagation models examined, it was concluded that the observed behavior of these ratios requires an additional mechanism operative at low energies. This mechanism may be adiabatic deceleration of cosmic rays in the solar wind. In order for this mechanism to be adiabatic deceleration, the deceleration in 1969 must have been such that particles observed at 10 to 20 MeV per nucleon had energies greater than 100 to 150 MeV per nucleon in the local interstellar space. (auth)

10114 COSMIC-RAY EFFECTS ON DIFFUSE GAMMA-RAY MEASUREMENTS. Fishman, G. J. (Teledyne Brown Engineering, Huntsville, Ala.). Astrophys. J.; 171: No. 1, 163-7(1 Jan 1972).

Calculations and experimental evidence from 600-MeV proton irradiation indicate that cosmic-ray-induced radioactivity in detectors used to measure the diffuse γ-ray background produces a significant counting rate in the energy region around 1 MeV. These counts may be responsible for the observed flattening of the diffuse photon spectrum at this energy. (auth)

10115 LATITUDE, ALTITUDE, AND PRIMARY MODULATION EFFECTS ON THE MULTIPLICITY DISTRIBUTION IN THE NM-64 NEUTRON MONITORS. Iucci, N. (Univ., Rome. CNR, Rome); Storini, M.; Villoresi, G.; Griffiths, W. K. Nuovo Cim.; 6B: No. 2, 111-23(11 Dec 1971).

Multiplicity data obtained from the NM-64 neutron monitors of Rome and Leeds during the years 1967/68/69 were analyzed, together with those from the European survey done in the Summer of 1969 with a standard 3NM-64. The attenuation coefficients for different multiplicities were estimated; the variation of these coefficients with multiplicity, latitude, and altitude were generally found to be in agreement with other experimental and theoretical results. The latitude curves of the multiplicity intensities obtained from 0.8 to 6.3 GV were compared with those reported by Kodama and Inoue (1970). The primary modulation effect on the multiplicity distribution was studied in the case of sixteen Forbush decreases; an exponent K = 0.7 was obtained under the hypothesis of a power law for the modulation function. (auth)

10116 STUDY OF THE ENERGY SPECTRUM OF PRIMARY COSMIC RAYS IN THE ENERGY RANGE OF $\sim 5.10^{10}$ TO 3.10^{14} eV ON THE PROTON 1,2,3 SATELLITES. Akimov, V. V.; Grigorov, N. L.; Rapoport, I. D.; (and others) (Moscow State Univ. Inst. of Cosmic Investigations, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 327-9(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 385-8(1971).

The results of measurements of the proton spectrum of primary cosmic rays in the energy range 5×10^{10} to 10^{13} eV and of the spectrum of all primary cosmic-ray particles in the interval 10^{11} to 3×10^{14} eV are reported. It is demonstrated that the spectrum of all particles can be represented by superposing the proton spectrum on the power spectrum of nuclei with $Z \geq 2$. (auth)

10117 ENERGY SPECTRUM OF ELECTRONS IN THE HIGH-ENERGY RANGE. Zatsepin, V. I.; Rubtsov, V. I.; Svirzhevskii, N. S. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 352-7(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 417-23(1971).

New experimental data on the differential spectrum of galactic electrons in the energy range 5 to 160 GeV are reported. It is demonstrated that the differential spectrum can be represented in this energy range in the form $dN/dE = (135 \pm 5)\ E^{-2.9\pm0.05}\ m^{-2}sec^{-1}ster^{-1}\ GeV^{-1}$. The data obtained are compared with those of other authors. The astrophysical significance of investigations of the energy spectrum is discussed. (auth)

10118 EFFECT OF IONIZATION LOSSES ON THE COSMIC-RAY SPECTRUM. Velinov, P. (Geophysical Inst., Sofia). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 358-62 (1971).

Translated from Geomagn. Aeron.; 11: No. 3, 424-8(1971).

The effect of ionization losses on the cosmic-ray spectrum is examined. This effect is significant in the range of nonrelativistic energies. The first part of this paper investigates the effect of ionization losses in the region of accelerated particles and the second, the effect of losses during the propagation of cosmic particles that are accelerated in primary sources. The corresponding particle spectra are obtained by solving the transport equation in specific cases with allowance for losses. (auth)

10119 ENERGY SPECTRUM OF SOLAR COSMIC RAYS AND POLAR-CAP ABSORPTION. Driatskii, V. M.; Krupitskaya, T. M.; Shirochkov, A. V. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 363-7(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 429-34(1971).

The polar-cap absorption event of May 24–25, 1967 is described on the basis of riometer data from the Arctic and Antarctic. Data on solar cosmic-ray fluxes, which were recorded by Explorer 34 and were responsible for the formation of an ionized region in the lower ionosphere in this period, are analyzed. A comparison of these data leads to the conclusion that this PCA event was produced by protons with $E > 10$ MeV during the daytime and protons with $E = 5$ to 10 MeV at night. (auth)

10120 THEORY AND SEARCH FOR DETAILED COSMIC-RAY ANISOTROPIES. Barrowes, Steven Clark. Salt Lake City; Univ. of Utah (1971). 145p. University Microfilms Order No. 72-1140.

Thesis.

A theoretical model is presented that predicts the type of anisotropy that would be caused if a source of cosmic rays were located along galactic magnetic field lines that pass near the earth. An experimental search for the predicted type of narrow-angle cosmic-ray anisotropy was made. Although no anisotropy was found in this experiment, the theory is successfully compared with other experimental results that have previously been unexplained. The existence of even a few narrow-angle anisotropies is evidence in favor of the assumption of a fairly regular galactic magnetic field, with a limited amount of scattering by small-scale magnetic irregularities. By assuming that the sources are pulsars (rotating neutron stars) or white dwarfs, the frequency of anisotropy occurrence is predicted, and some predictions are made concerning the charge composition at high energies and the break in the primary spectrum at about 3×10^{15} eV. (Diss. Abstr. Int., B)

Direct Energy Conversion

10121 (UCRL-51147) DIRECT ENERGY RECOVERY FROM A BEAM OF CHARGED PARTICLES USING PARABOLIC ION TRAJECTORIES. Barr, W. L. (California Univ., Livermore. Lawrence Livermore Lab.). 11 Nov 1971. Contract W-7405-eng-48. 9p. Dep. NTIS.

An electrostatic system capable of recovering the energy from a beam of charged particles is described. The particles can have a wide energy spectrum, but to recover the energy with high efficiency the following conditions must be satisfied: (1) the entrance aperture must be small relative to the length; (2) the angular spread of the entering beam must be less than about ±0.04 radian; and (3) the charge density must be low so that space charge does not seriously modify the electric field. Each of these conditions is considered separately. Space charge is the most serious problem and probably prevents this system from being useful on a thermonuclear reactor. (auth)

10122 PRE-IONIZATION OF THE WORKING MEDIUM IN A MHD GENERATOR GEOMETRY BY NUCLEAR REACTIONS. Stolyar, L. P.; Trushin, V. S. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 413-15(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 450-1(Mar-Apr 1971).

The problem of establishing the initial ionization by exposing the gas to neutrons generated in a reactor is discussed. Radioactive decay results in the release of β particles with energies of the order of several MeV; the β particles serve to ionize the gas. Energy considerations are described. (M.O.W.)

10123 EXPERIMENTAL INVESTIGATION OF THE EFFECT OF BOUNDARY LAYERS ON THE CHARACTERISTICS OF A MAGNETOHYDRODYNAMIC GENERATOR OVER A WIDE RANGE OF HALL NUMBERS. Scheindlin, A. E.; Buznikov, A. E.; Vanin, V. E.; Kirillov, V. V.; Sokolov, Yu. N. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 348-55(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 386-94(Mar-Apr 1971).

Results are presented of an experimental investigation of the characteristics of the MHD generator for operation with equilibrium argon–potassium plasma. Generalized dependences of the short-circuit currents and Hall voltage were obtained in the range of Hall numbers from 2 to 25 for relative electrode-wall temperatures of 0.35 to 0.7 and a relative boundary-layer thickness on the electrode wall equal to $\overline{\delta}_y = 0.14$ to 0.18. (auth)

10124 EXISTENCE OF CONDENSED SLAGS IN A MAGNETOHYDRODYNAMIC GENERATOR. Garkusha, L. K.; Shchegolev, G. M. (Inst. for Industrial Thermophysics, Kiev). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 362-5(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 401-4(Mar-Apr 1971).

One of the promising fuels for magnetohydrodynamic plants operating with an open cycle is coal. At high temperatures, conditions for the vaporization of slags are created in the combustion chamber of a magnetohydrodynamic plant. Therefore, the existence of a condensed phase in the combustion chamber and in the channel of a magnetohydrodynamic generator is not evident. To solve the problem of the state region to which stable combustion products with given parameters should be assigned, the parameters of the dew point of the slag vapors may be used as criteria. The present article expounds a method for calculating the dew point of the slag vapors and gives the results of a calculation for the combustion products of Karagandinskii coal. A conclusion is drawn as to the possibility of the existence of condensed slags in the combustion chambers of magnetohydrodynamic plants, operating on coal. (auth)

10125 INDUCTION MAGNETOHYDRODYNAMIC GENERATOR WITH A HOLLOW NUCLEAR REACTOR. Dmitrievskii, V. A.; Zaklyaz'minskii, L. A. (Inst. of High Temperatures, Moscow. Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 366-72(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 405-12(Mar-Apr 1971).

An attempt was made to determine the scheme of a generator, starting from the conditions necessary for attaining certain of its given characteristics. These characteristics, which determine both the quality of the operation of the generator and the possibility of putting it into practice are the following: (1) achievement of a high efficiency ($\eta \geq 0.5$) only using direct transformation, i.e., in the magnetohydrodynamic channel; and (2) the walls of the generator must be sufficiently cold ($T \leq 1000°K$) so that they can be fabricated from presently existing materials. The transition from the specifications formulated to the scheme of the generator is discussed. An approximate evaluation is made of the parameters and dimensions of the generator. Concepts are expressed with respect to the working body of such a generator and with respect to its properties at high temperatures. (auth)

10126 EFFECT OF CATHODE AND ANODE TEMPERATURE ON THE ELECTRON COMPONENT OF THE THERMAL FLUX IN THE ARC MODE OF A THERMOELECTRIC CONVERTER. Maksimov, V. A.; Titkov, A. S. High Temp. (USSR) (Engl. Transl.); 9: No. 2, 215-19(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 240-5(Mar-Apr 1971).

Measurements show that the effective heat of condensation of the electrons on the anode of a thermoelectric converter is almost independent of the cathode temperature. The change in q_e^* with changing anode temperature is analogous to the change in the work

function of a metal surface simply situated in cesium vapor. An analysis of the q_c^* (T_s) and q_c^* (T_{Cs}) relationships, together with the V/A characteristics of the system, suggests the existence of a "virtual" anode in the region close to the anode of the thermoelectric converter when the latter is operating in the arc mode. A comparison of the q_c^* (T_s) relationship with q_c^* (T_{Cs}) shows that the change in q_c^* with T_{Cs} is principally associated with a change in the "virtual" anode rather than a change in the work function of the anode surface. (auth)

Fluid Physics

Refer also to abstract 9984.

10127 MAGNETOHYDRODYNAMICS OF A DROP. Narain, Jai Prakash (Univ. of Colorado, Boulder); Uberoi, Mahinder S. Phys. Fluids; 15: No. 1, 62-9(Jan 1972).

The nature of deformation and drag on a spherical drop of viscous, conducting, and incompressible fluid under axisymmetric current distribution in a conducting, viscous, incompressible fluid of infinite extent is considered. The drop fluid and the ambient fluid phases are nonreacting and nondiffusive in nature. In low magnetic Reynolds' number approximation, the effects of space charge, either on the total force density or on the distribution of conduction currents are neglected. In the absence of any free induced currents, the drop deformation to oblate or prolate spheroidal shape in Stokes' approximation is primarily determined by the difference in conductivities and permeabilities of two fluid phases. The drag remains the same as that on a spherical drop in a noncurrent-carrying fluid because of axisymmetric current distribution. In Oseen's approximation, the drop deformation to oblate spheroidal shape is aided by inertia of flow for large values of drop to ambient fluid density ratio, whereas inertia retards the deformation to prolate spheroidal shape. The drag on the drop increases (or decreases) from its zero-current carrying ambient fluid counterpart depending on difference in conductivities of two fluid phases. The terminal velocity remains unaffected by currents in Stokes' approximation, but it increases or decreases from its zero-current-carrying ambient-fluid counterpart value in Oseen's approximation, depending on whether the drop has higher or lower conductivity than the ambient fluid. The drag and terminal velocity remains unaffected by the permeability of the drop fluid in these approximations. In higher order, the drop tends to a spherical cap shape since the electromagnetic effects are extremely small in this order. (auth)

10128 MAGNETOHYDRODYNAMIC BOUNDARY LAYER. Pop, I. (Babes-Bolyai Univ., Cluj). Inzh.-Fiz. Zh.; 20: No. 6, 1053-9(Jun 1971). (In Russian).

The growth of two-dimensional boundary layer flow of an incompressible, viscous, and electrically conducting fluid in the presence of a transverse magnetic field is considered, when the velocity outside the boundary layer and magnetic field are assumed of the form: $U(x,t) = V(x)\Omega(t)$, $B(x,t) = Bo(x)\sqrt{\Omega(t)}$, $\Omega(t) = At^{\alpha}(1 + A_1t^n)$. The solution is found in the assumption that the motion starts impulsively from rest and continues with uniform acceleration. The expressions for the first two approximations of velocity in the boundary layer are obtained. (auth)

10129 HEAT TRANSFER IN LAMINAR MAGNETOHYDRODYNAMIC BOUNDARY LAYERS ON CONTINUOUS SURFACES. Rhodes, C. A. (Univ. of South Carolina, Columbia). pp FC1.3.1-10 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

The flow and heat-transfer characteristics in the boundary layer of a continuous moving surface in a magnetic field are studied analytically. This flow situation occurs when a continuous flat plate moves into a conducting fluid with a magnetic field perpendicular to the direction of motion. A similar condition occurs behind a shock wave moving into a stationary fluid in shock tube magnetohydrodynamic experiments. (auth) (France)

10130 ELECTROTHERMAL CONVECTION EFFECTS WITH LAMINAR FLOW HEAT TRANSFER IN AN ANNULUS. Porter, J. E.; Poulter, R. (Univ. of Newcastle upon Tyne, Eng.). pp FC3.7.1-11 of Heat Transfer 1970. Vol. II. /Grigull, Ulrich (ed.). Amsterdam; Elsevier Publishing Co. (1970).

From fourth international heat transfer conference; Paris–Versailles, France (31 Aug 1970).

Heat transfer rates in insulating liquids can be affected by the presence of electric fields. The present study is concerned with such phenomena, and especially their influence on heat transfer in an annulus where flow conditions, in the absence of the electric field, are laminar. In general dc fields (predominantly radial) increase heat transfer coefficients considerably, and although these increases are accompanied by increased axial pressure drop, the coupling between heat transfer and pressure drop is more advantageous than that associated with normal convection processes. This coupling, together with the electrical current measurements, indicates the nature of the underlying physical process and forms the basis for a proposed heat transfer model. (auth)

10131 HIGH-TEMPERATURE RADIATIVE TRANSFER AND HYDRODYNAMICS. Pomraning, G. C. (Science Applications, Inc., La Jolla, Calif.). Progr. High Temp. Phys. Chem.; 4: 1-83(1971).

An equation of radiative transfer is derived that contains the dominant physics of radiant heat transfer. Conditions for its validity and physical effects that it neglects are discussed. A mathematical simplification of this equation is also derived that is widely used in practice, namely the Eddington or diffusion approximation. Recent work involving the scattering interaction of photons with electrons is described within the context of the equation of transfer. Refinements of the equation of transfer due to the effects of dispersion, polarization, and fluid motion are discussed. The relativistic equations of hydrodynamics including the contributions to these equations due to the radiation field are derived in both Eulerian and Lagrangian form. (W.D.M.)

10132 VELOCITY MEASUREMENTS IN REGIONS OF UPSTREAM INFLUENCE OF A BODY IN ALIGNED-FIELDS MHD FLOW. Lake, Bruce M. (California Inst. of Tech., Pasadena). J. Fluid Mech.; 50: Pt. 2, 209-31(29 Nov 1971).

Experiments are described in which velocities were measured ahead of a semi-infinite Rankine body moving parallel to a uniform magnetic field in a conducting fluid. The flow disturbance in front of the body is found to increase in length as $N^{\frac{1}{3}}$, where N is the interaction parameter. In most of the experiments this parameter was varied from 4 to about 50. Measurements made along the axis of symmetry in the flow show that there is a relatively short region of stagnant fluid directly ahead of the body. The major part of the disturbance is found to consist of a much longer region in which the flow undergoes transition from conditions in the free stream to conditions near the body. Velocity profiles across the flow in this region show that for increased N, at a fixed distance ahead of the body, the velocity defect increases and the disturbance becomes more confined radially. Although the radial gradients in the flow increase with N, they are found to be much smaller than would be expected in a flow containing thin current layers. A physical model of the flow which has currents and pressures consistent with these results is discussed. (auth) (UK)

Upper Atmosphere Physics

Refer also to abstracts 9339 and 11071.

10133 (JPRS-54718) INVESTIGATIONS OF THE ATMOSPHERE AND IONOSPHERE DURING PERIOD OF INCREASED SOLAR ACTIVITY. Mikhnevich, V. V.; Danilova, A. D. (eds.). Translated from Issledovaniya Atmosfery i Ionosfery v Period Povyshennoy Solnechnoy Aktivnosti, 1970, Hydrometeorological Publishing House, Leningrad. 189p. NTIS.

The results are given of measurements taken of parameters of the atmosphere and ionosphere by rocket, radiosonde, and ground-based methods during the period of heightened solar activity from March–April 1969. The rocket measurements were achieved with the aid of equipment mounted on the MR-12 and M-100 meteorological rockets. Ground-based observations were conducted at ground ionospheric radiosonde stations and with the aid of radar for detecting meteor trails. Use was also made of the data from a network of aerological and meteorological stations. A relationship was established between solar activity, corpuscular fluxes, ionization in the ionosphere, and also the circulation and structure of the Earth's lower and upper atmosphere. (tr-auth)

10134 DEEP-SPACE PLASMA MEASUREMENTS. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). Methods Exp. Phys.; 9: 49-88(1971).

Experimental methods used for the study of plasma in extraterrestrial space by means of instruments carried on Earth satellites and space probes are described. Only measurements beyond the plasmasphere are considered. (46 references) (M.O.W.)

10135 WHISTLERS: DIAGNOSTIC TOOLS IN SPACE PLASMA. Brice, Neil M. (Cornell Univ., Ithaca, N. Y.); Smith, Robert L. Methods Exp. Phys.; 9: 89-137(1971).

The whistler technique provides information on the parameters relating to the Earth's ionosphere and magnetosphere. These

include the magnitude of the electron density and its spatial and temporal variation (including irregularities and gradients in density), ion density, composition, and temperature. Movement of ionization can be detected and interpreted as a measure of large-scale quasi-static electric fields. The information arises in part from the nature of the radio waves emanating from a lightning discharge. Analysis of the radiation received at some distance from the source provides information on the impulse response of the intervening medium, resulting in terms of the parameters of the propagation medium. The experimental method is explained. Ground-based whistler observations are applied and information and data are included on echo trains, nose whistlers, ducting, knee whistlers, and electric-field measurements. Satellite observations have produced data on ducted whistlers; multiple-ion and ion effects; coupling phenomena; proton-whistler correlation with magnetic-field strength, proton-number density, and proton temperature; helium whistlers; and ion-cutoff whistlers. Wave propagation in multiple-ion plasma is discussed in an Appendix. (40 references) (J.C.W.)

10136 RADIO-WAVE SCATTERING FROM THE IONOSPHERE. Farley, D. T. (Cornell Univ., Ithaca, N. Y.). Methods Exp. Phys.; 9: 139-86(1971).

Ionosonde measurements made from the Earth and satellites are discussed. Radar-scattering measurements made from the ground at frequencies of 50 MHz or higher are detailed. General features of all scatter measurements, incoherent scatter and the much stronger scattering from unstable regions, and scattering from the equatorial electrojet are considered from the theoretical and experimental aspects. Specifically, plasma experiments in the E region (altitudes in the vicinity of 100 km) and F region (above about 200 km) of the ionosphere are described. A very wide range of observations has been completely explained by the linearized kinetic theory. The instability theory is not so far advanced, but some aspects have been accounted for in the experiments. (72 references) (J.C.W.)

10137 SUNSPOT CYCLE 1958/70 IN IONOSPHERIC ABSORPTION AND STRATOSPHERIC TEMPERATURE. Schwentek, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 33: No. 12, 1839-52(Dec 1971).

It is shown that the effect of the sunspot cycle 1958/70 on ionospheric absorption in the D-region determined daily at Lindau at 2.6 MHz (method A3) and temperature in the stratosphere measured daily by radiosonde launchings at West Berlin is very pronounced in winter but small in summer. The dependence of absorption on sunspot number is considerably different in the seasons; the minimum is in March, the maximum in January. It is $L(R, \cos\chi = 0.1, 2.6\ MHz) = L(R = 0)[1 + aR]$; a increases steadily from March to January. In summer, stratospheric temperature, T, is approximately constant over the whole sunspot cycle 1957/70. In winter, however, the temperature increases with sunspot number, R, in the range from R = 0 to 160 by, 5°C at 25 km, 16°C at 30 km, 27°C at 35 km, 40°C at 40 km; for R greater than about 170 the temperature decreases. This behavior of T with regard to R was also found for the solar constant by Bossolasco et al. (1965). In summer, most clearly at 25 km, T shows unambiguously a biennial oscillation (26 months?); the amplitude is of the order of ±0.5°C. The same period and phase is also detectable in the absorption data L(2.6 MHz; summer; $\cos\chi = 0.1$). (auth)

10138 DEFINITION OF COLLISION FREQUENCIES AND THEIR RELATION TO THE ELECTRON CONDUCTIVITY OF THE IONOSPHERE. Suchy, K. (Groupe de Recherches Ionospheriques, St. Maur, France): Rawer, K. J. Atmos. Terrest. Phys.; 33: No. 12, 1853-68(Dec 1971).

Among several possible definitions of collision frequencies in the kinetic theory of gases those which are most advantageous for estimates of the accuracy of approximations were selected. Without giving detailed kinetic theory calculations, expressions for the electron conductivity in several approximations are presented, together with criteria for their applicability in the ionosphere. (auth)

10139 GLOBAL MORPHOLOGY OF THE QUANTITY $\int N\nu\,.dh$ IN THE D AND E REGIONS OF THE IONOSPHERE. George, P. L. (Science Research Council, Slough, Eng.). J. Atmos. Terrest. Phys.; 33: No. 12, 1893-1906(Dec 1971).

Vertical incidence absorption data obtained by the pulse reflection method of vertical incidence sounding, mainly during the IGY and IQSY, were used to establish the worldwide morphology of the integrated product with respect to height of the electron concentration and collision frequency ($\int N\nu\,.dh$), through the D and E regions of the ionosphere. This quantity is of fundamental importance in absorption studies. Substantial variations of $\int N\nu\,.dh$ with latitude exist in any given season that are comparable in magnitude to the variation seen at a fixed geographical position during the full solar cycle. A maximum of $\int N\nu\,.dh$ occurs at low latitudes during all seasons with an associated trough centred on the magnetic equator. The seasonal variation at these low latitudes is semi-annual with small maxima at the equinoxes. At middle and high latitudes there is no significant latitudinal variation during the summer and equinoxes. During winter the well-known anomalous behavior of absorption appears in $\int N\nu\,.dh$ in the form of an enhanced zone within which the winter values can exceed those attained during summer by up to 100%. The equinoctial values in this zone are 15 to 20% above the summer value. (auth)

10140 PHOTOIONIZATION YIELDS OF O, O_2, AND N_2 FOR HIGH AND LOW SOLAR ACTIVITY. Schlegel, K. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 33: No. 12, 1923-31(Dec 1971).

Photoionization yields of O, O_2, and N_2 were calculated with the help of a Monte Carlo simulation of a model ionosphere. In this model the magnetic field, the influence of Coulomb scattering, and various excitation and ionization processes were taken into account. The photo-ionization yields depending on altitude, photon wavelength, and solar activity were expressed in a simple analytical form for easy use in calculations. (auth)

10141 RADIO-SCINTILLATION METHOD OF ESTIMATING SMALL-SCALE STRUCTURE IN THE IONOSPHERE. Rufenach, C. L. (Environmental Research Labs., Boulder, Colo.). J. Atmos. Terrest. Phys.; 33: No. 12, 1941-51(Dec 1971).

The power spectra of the intensity fluctuations for the radio source Cygnus A were analyzed for 44 nights during the summer of 1970. When the scattering was weak, oscillations were observed in the power spectra. These oscillations are attributed to a Fresnel filtering effect. When present, these oscillations are used to calculate the velocity and to estimate the irregularity scale size and the rms electron density fluctuations for irregularities smaller than the Fresnel radius. On many occasions the power law intensity spectra for structure smaller than the Fresnel radius may be attributed to a power law electron-density spectrum. (auth)

10142 STUDY OF TWO FLARES ON 8 JULY 1968 IN THE LIGHT OF THEIR IONOSPHERIC EFFECTS. Sengupta, P. R. (Indian Inst. of Tech., Kharagpur). J. Atmos. Terrest. Phys.; 33: No. 12, 1953-71(Dec 1971).

Ionospheric effects of the x-ray flare on July 8, 1968 on vlf propagation show excellent agreement with the formula derived on the assumptions: (i) the flare-induced ionization within the limited altitude range of interest near the vlf reflection height can be approximated as due to an equivalent monochromatic radiation at an effective wavelength λ_{eff} depending on the spectral distribution of 0.3- to 8-Å flare emission and intensity proportional to 1- to 8-Å flux; and (ii) the electron loss coefficient below 70-km height is proportional to the total number density of the atmospheric constituents. It is shown that the λ_{eff} is a measure of the spectral hardness of the flare emission, and the hardness factor of the flare spectrum can be successfully estimated by combining the vlf data with the measured flux (1- to 8-Å). A method was developed for computing the 0.3- to 12-Å spectral distribution for the flare emission from the measured 1- to 8-Å and 2- to 12-Å flux values and the observed SID's. The electron-density profiles obtained from the computed spectral distribution and the measured flux (2- to 12-Å) accounts for all the observed SID's. The electron loss coefficients below 70-km height calculated using formula developed in the analysis are in agreement with the available data. (auth)

10143 NOCTURNAL ABSORPTION OF RADIO WAVES DUE TO THE IONISATION PRODUCED BY X-RAYS FROM Sco X-1 AND Tau X-1 IN THE LOWER IONOSPHERE. Chakravarty, S. C. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A; 74: No. 3, 99-114(Sep 1971).

The night-time attenuation of lf radio waves of frequency 164 kHz transmitted from Tashkent and received at Ahmedabad was found to have a sidereal time variation which is associated with the transits of the x-ray stars Sco X-1 and Tau X-1. Using the full-wave admittance method of Barron and Budden for calculating the intensity and polarization of lf radio waves reflected from the ionosphere during night time, when the atmosphere is irradiated by x rays from Sco X-1 and Tau X-1, the attenuation of 164-kHz waves transmitted from Tashkent and received at Ahmedabad was calculated and compared with the observed results. The agreement was reasonably satisfactory. (auth)

10144 REALITY OF SOLAR–ATMOSPHERIC RELATIONSHIPS. Loginov, V. F.; Sukhomazova, G. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.): 11: No. 3, 335-8(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 396-400(1971).

The reality and sign-variability of Sun–atmosphere relationships are discussed. It is concluded that these relationships differ in character in the warm and cold periods of the year. Some assumptions are made on the reasons for their sign variability. (auth)

10145 RECORDING OF ADDITIONAL ELECTRON FLUXES AFTER MAGNETIC DISTURBANCES. Volobuev, S. A.; Gal'per, A. M.; Dmitrenko, V. V.; (and others) (Moscow Engineering-Physics Inst.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 348-51(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 412-16(1971).

High-altitude balloon experiments ($\Phi = 46$ and 49°) revealed that an additional flux of electrons with $E > 100$ MeV appears in the upper layers of the atmosphere on days following magnetic disturbances. The intensity of this flux, which amounts to $\sim 6 \times 10^{-2}$ $(cm^2 sec \cdot ster)^{-1}$ ($\Phi = 46°$) at the beginning of a disturbance, decreases with a characteristic time of 20 to 30 hours. (auth)

10146 TEMPERATURE VARIATIONS AND THE STRUCTURE OF THE NIGHTTIME ATMOSPHERE (IONOSPHERE). Mirtov, B. A. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 368-72(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 435-40(1971).

Some patterns in the variation of gas-particle concentration during variations in both the gas-kinetic and electron temperatures of the nighttime polar atmosphere are determined theoretically. The inverse problem is also solved approximately, i.e., T_n and T_e are determined from data on ion composition. A specific example of computation of the missing structural parameters of the atmosphere (O, N, O_2, N_2, N^+, N_2^+, q, T_e and T_n) is analyzed on the basis of experimental data on the composition of the ionosphere (O^+, O_2^+, and NO^+) and data on some aeronomic reaction constants. The gas-kinetic temperatures of the atmosphere are found to be relatively low for quiet conditions during the polar night. (auth)

10147 NONLINEAR INTERACTION OF LONGITUDINAL WAVES EXCITED BY A PLASMA INSTABILITY IN THE EQUATORIAL ELECTROJET. Kamenetskaya, G. Kh. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 377-82(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 446-52(1971).

The excitation of longitudinal waves outside the region of linear growth by a nonlinear jump of energy from the region where a wave is generated by the electrojet is analyzed. The nonlinear current that gives rise to new waves is found from quasi-hydrodynamic equations of charged-particle motion. It is demonstrated that for wave intensities on the source region the energy density of secondary waves may exceed by 3 to 4 orders of magnitude the energy density of thermal fluctuations. (auth)

10148 EFFECT OF FLUCTUATIONS IN ELECTRON DENSITY AND COLLISION FREQUENCY ON THE FORM OF N(h) PROFILES, DETERMINED BY THE METHOD OF PARTIAL RADIO WAVE REFLECTIONS. Grishkevich, L. V.; Ivanov, V. A.; Fedoseeva, T. N. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 388-92(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 458-63(1971).

The combined effect of fluctuations in electron density, ΔN, and in the number of collisions, $\Delta\nu_m$, on the form of N(h) profiles in the ionospheric D region, determined by the method of partial radio-wave reflections, is analyzed. If $\Delta\nu_m$ occur along with ΔN in the height interval 55 to 70 km, considerable errors can occur in the determination of the N(h) profile of this part of the ionosphere because of the failure to allow for the effect of $\Delta\nu_m$ on the partial reflection coefficients of the magneto-ionic components. (auth)

10149 ION-ACOUSTIC INSTABILITY AND DRIFT IN THE IONOSPHERE IN THE PRESENCE OF A FAST-PARTICLE INHOMOGENEITY. Tsedilina, E. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 393-7 (1971).

Translated from Geomagn. Aeron.; 11: No. 3, 464-8(1971).

The results of computations of the magnitude of the transverse electric field in the ionosphere in the presence of a fast-electron inhomogeneity are analyzed. Electron and ion drift and the possibility of the appearance of ion-acoustic oscillations in the ionosphere are discussed on the basis of these results. (auth)

10150 ELECTRIC FIELD IN IONOSPHERE AND MAGNETOSPHERE IN PRESENCE OF A FAST-ELECTRON INHOMOGENEITY. Soboleva, T. N.; Tsedilina, E. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 398-401 (1971).

Translated from Geomagn. Aeron.; 11: No. 3, 469-73(1971).

Results are reported of a numerical computation of the electric field in the earth's ionosphere and magnetosphere in the presence of a fast-electron inhomogeneity having a density distribution maximum on the shell $L = L_{max} = 3$. (auth)

10151 PRELIMINARY RESULTS OF NUMERICAL MODELING OF THE STRUCTURE OF A DISTURBED F1 REGION. Goncharova, E. E.; Koshelev, V. V.; Shchepkin, L. A.; Yudovich, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 406-8 (1971).

Translated from Geomagn. Aeron.; 11: No. 3, 479-82(1971).

Quiet and disturbed conditions were modeled from data on $n_e(h)$ profiles for daylight hours to study the behavior of the ion structure during disturbances. Jacchia's model was used for the neutral atmosphere. (auth)

10152 LATITUDINAL DISTRIBUTION OF ELECTRON TEMPERATURE IN SUMMER IN DAYTIME F2 LAYER. Potapova, N. I.; Shapiro, B. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 409-11(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 483-6(1971).

The latitudinal variations of T_e/T_i and T_e at the level of the F2-layer maximum in summer at low solar activity are estimated from the geometric parameters of N(h) profiles. The T_e/T_i and T_e values are found to increase with geomagnetic latitude. The latitudinal distribution of T_e/T_i is controlled by N_m^2. For $N_m > 4$ to 5×10^5 el $\cdot$ cm^{-3}, the H_{Ch} ($H_{Ch} = 1.1q_c$) values approach the H_n values and increase sharply for $N_m < 2.5$ to 3×10^5 el $\cdot$ cm^{-3}. The heat flux producing the observed temperature difference ($T_e - T_n$) and the energy accumulated by the electron gas in a column to h_{max} are computed. (auth)

10153 CORPUSCULAR NATURE OF D-LAYER IONIZATION. Kochenova, N. A.; Fligel, M. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 412-16(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 487-92(1971).

The hypothesis of D-region ionization by electron fluxes is used to explain the latitudinal pattern of radio-wave absorption in it. The differential electron spectrum is computed and the energy spent on ionization is determined. (auth)

10154 VIBRATIONALLY EXCITED OXYGEN IN THE UPPER ATMOSPHERE. Vlasov, M. N. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 426-31(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 504-11(1971).

Several processes of formation and loss of vibrationally excited O_2^{**} molecules were analyzed. The equilibrium densities of these molecules with different excitation levels in the height interval 60 to 140 km are computed for the daytime and night. A comparison of the O_2^{**} (v = 1) densities obtained with the O_2^{**} (v = 1) corresponding to a Boltzmann distribution showed that the vibrational temperature for molecular oxygen is close to the temperature of the ambient gas, both during the daytime and at night. But the ratio of O_2^{**} (v > 1) density to O_2^{**} (v = 0) density does not obey the Boltzmann distribution. The ionization rates of O_2^{**} (v = 11) by solar L_α emission and of O_2^{**} (v = 3 to 8) by solar radiation at 1027 to 1118 Å are computed. These processes can be an important ion source in the ionospheric D-region. (auth)

10155 CONTRIBUTION OF THE ATMOSPHERIC EFFECT TO THE SOLAR-DIURNAL VARIATION OF THE MUON COMPONENT. Kuz'min, A. I.; Skripin, G. V.; Filippov, V. A. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 442-4(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 523-5(1971).

The contribution of the temperature effect to the diurnal variations of the meson component on the basis of data obtained between 1958 and 1969 at Yakutsk by means of a set of crossed telescopes was determined. The method of crossed telescopes permits determining the main asymptotic characteristics of anisotropy and also the contribution of the temperature effect to the diurnal-intensity variations of the meson component. It is seen that the temperature effect in the diurnal variations of meson component intensity is substantial only at the surface of the Earth, whereas at a depth of 20 mwe it is much smaller and lies within the limits of measurement accuracy. There is good agreement between the parameters of the effect at the surface of the Earth and the estimates obtained from observations at Deep River. The seasonal variations of the temperature-induced diurnal variation in the period 1958–1969 were also computed. (J.C.W.)

10156 CADMIUM RATIO FOR INDIUM AND FOR THE 1/v DETECTOR IN THE FIELD OF ATMOSPHERIC NEUTRONS. Abdurakhmanov, A. Kh.; Efimov, Yu. E.; Romanov, A. M.; Chichikalyuk, Yu. A. (Ioffe Inst. of Physics and Tech., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 444-6(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 526-7(1971).

The ratio of epithermal and thermal neutron flux in a field was investigated from measurements and by computations made in the summer of 1968 at a geomagnetic latitude of 57°N at a depth in the atmosphere at 225 g · cm^{-2}. The detector is an asymmetric sandwich of three indium layers, area ~5000 cm^2, and packed in special aluminum holders. The cadmium ratio is defined as the ratio of the neutron recording rate by an open detector and a detector screened by a cadmium layer 0.5- to 1-mm thick. The cadmium screen absorbs all the thermal neutrons and transmits practically all the epithermal neutrons. (J.C.W.)

10157 TRANSFORMATION OF IONOSPHERIC CURRENTS INTO LONGITUDINAL CURRENTS FLOWING ALONG GEOMAGNETIC LINES OF FORCE IN THE MAGNETOSPHERE. Davydov, V. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 446-9(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 528-9(1971).

A mechanism is described for the transformation of ionospheric currents into longitudinal currents that flow along geomagnetic lines of force and then reenter the ionosphere at magnetically conjugate points. The mechanism refers to the specific case when the ionospheric current is a horizontal eddy current. The fluctuations are in the low-frequency range with periods exceeding 14 to 30 sec. A sufficient condition for the existence of longitudinal currents in the magnetosphere is known to be the presence of an electric field intensity component parallel to the lines of force. It is demonstrated that an eddy current in the ionosphere forms vertically oriented lines of force in the magnetosphere. (J.C.W.)

10158 EFFECT OF A NONDIPOLE GEOMAGNETIC FIELD ON THE COMPONENTS OF THE ELECTRIC CONDUCTIVITY TENSOR OF THE DYNAMO REGION OF THE IONOSPHERE. Dvinskikh, R. Kh.; Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 449-50(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 530-1(1971).

Results of computations for electric conductivities in any orthogonal coordinates used in practice are given, using expressions for the generalized electric-conductivity tensor of the dynamo region of the ionosphere. It is shown that allowance for the nondipole part of the magnetic field leads to a significant difference in the conductivity values, and this is pertinent when computing electric fields and current functions in the theory of the atmospheric dynamo. The large difference in the conductivity ratios in the equatorial region is attributable to the fact that, in the geographic coordinate system used, the location of the increase in electric conductivity, determined in the real and dipole approximation, does not coincide. (J.C.W.)

10159 EFFECT OF THE STATE OF THE ATMOSPHERE ON THE ION STRUCTURE OF THE IONOSPHERIC F1 REGION. Shchepkin, L. A.; Koshelev, V. V.; Shuyskaya, Z. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 451-2(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 532-3(1971).

The densities of the major ions at 140 to 220 km were computed for solar-zenith angles ranging from 20 to 70° and various states of the atmosphere to study the relationship between the state of the neutral atmosphere and the ion structure of the daytime F1 region. Jacchia's model of the neutral atmosphere was used, and the computations were performed in the equilibrium approximation for low solar activity and states of the atmosphere characterized by an exosphere temperature T_∞ = 650 to 1100°K. A definite density distribution of gas particles corresponds to each T_∞. The higher the temperature, the greater the total particle density in the region in question and the greater the concentration of molecules. Profile changes in the atmosphere were examined during the warming of the atmosphere. (J.C.W.)

10160 ELECTRON DENSITY DISTURBANCES IN THE F2 LAYER AND IN THE TOPSIDE IONOSPHERE DURING THE MAGNETIC STORM OF MARCH 10, 1963. Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 453-6(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 534-6(1971).

The results are reported of a study of the storm effect in the F2 layer on the integral electron density and on the $n_e(h)$ profiles in the topside ionosphere, which were obtained from an analysis of ground-based and topside soundings during the magnetic storm of March 10, 1963. To estimate the storm effect, the disturbed conditions on March 10 were compared with the conditions on March 3 and 5 control days. The effects at near-noon and the effects on the nightside of the Earth were analyzed. In the afternoon the negative disturbances in these two regions were clearly localized in latitude and height. A decrease in electron density during the storm was observed only at middle latitudes and was confined to 400 to 450 km. It is concluded that the behavior of the topside ionosphere at 400 to 450 km during a magnetic storm differs from that of the F2 layer, at least at middle latitudes. (J.C.W.)

10161 EFFECT OF VERTICAL DRIFT ON THE VERTICAL DISTRIBUTION OF ELECTRON DENSITY IN THE F2 REGION. Muradov, A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 456-8(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 537-9(1971).

Results are reported of numerical integration of the continuity equation in the F2 region for equilibrium conditions during the daytime with allowance for ionization–recombination processes, ambipolar diffusion, and uniform vertical drift. The quantitative characteristics of the effect of vertical drifts on the vertical distribution of electron density are emphasized. As diffusion increases, the integral electron density in the F2 region increases correspondingly. The effect of vertical drifts on the N(h) profiles for positive drift velocities agrees qualitatively with the effect of negative disturbances in the F2 layer when the height of the layer rises and the electron density in it decreases. The existence of considerable thermospheric winds with a southward-directed meridional component during geomagnetic storms has been indicated by Smith (J. Geophys. Res., 73: 4959(1968)). If similar winds occur at F2-region heights, the vertical component of plasma motion arising in this case can be responsible for the behavior of the F2 region during ionospheric storms. (J.C.W.)

10162 ALLOWANCE FOR UNDERLYING IONIZATION IN THE ABSENCE OF AN X TRACE OF THE E LAYER. Mal'tseva, O. A. (Rostov State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 460-2(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 542-3(1971).

Underlying ionization is taken into account when analyzing nighttime and daytime ionograms, but the nighttime ionograms always contain the x trace of the F layer needed for corrections, whereas the x trace of the E layer is frequently missing on daytime ionograms. Underlying ionization is taken into account (1) from the x trace of the F region, and (2) from the x trace of a type-c E_s layer when computing from daytime ionograms. When the x traces of E, E_s, and F appear simultaneously it is confirmed that separate use of the x traces of E, E_s, and F (in the absence of the corresponding traces) leads to the same results (the same equivalent parameters of the underlying region). (J.C.W.)

10163 EQUIVALENT SECONDARY MULTIPOLES, ALLOWING FOR HALL CONDUCTIVITY AND THE SLOPE OF GEOMAGNETIC LINES OF FORCE IN THE LOWER IONOSPHERIC LAYERS. Davydov, V. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 462-4(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 544-6(1971).

The possibility of allowing for the effect of Hall conductivity and of the inclination of the lines of force of the geomagnetic field on the magnetic field of local ionospheric currents by means of secondary equivalent sources is discussed. An idealized model for the solution of this problem is a gyrotropic plane approximating the lower layers of the ionosphere. The local ionospheric currents are taken into account by dipole sources. A system of two semi-finite vertical currents that are out of phase and correspond to a three-dimensional Alfven wave is analyzed. The equivalent secondary sources introduced to allow for the Hall and anisotropic parts of magnetic fields are horizontal and vertical electric dipoles and horizontal and vertical magnetic dipoles. The significance of the secondary equivalent multipoles introduced permits representation of the characteristic features of magnetic fields produced by Hall conductivity and the slope of the lines of force of H in the ionosphere. In the case of an arbitrary dipole source the multipoles permit deriving some characteristics of the fields from solutions solely for the horizontal electric or vertical magnetic dipoles in the presence of simpler media. (J.C.W.)

10164 INVESTIGATION OF IONOSPHERIC DISTURBANCES BY THE INTERFERENCE METHOD. Afraymovich, E. L.; Kudelin, G. M.; Troitskii, B. V. (Ionospheric Sector, Kazakh, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 468-71(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 550-2(1971).

The interference method was used to investigate traveling ionospheric disturbances during vertical sounding in the entire frequency range of an ionosonde. The method was verified during measurements of group path as a function of operating frequency and time. It was shown that the interference method improves the resolution of an ionosonde during group-path measurements by a factor of more than 10. This makes it possible to investigate the formerly forbidden region of group-path values <20 km [so-called unresolved segment of z′(f)]. The method makes it possible to investigate the TID spectrum of broad intensity, opening new possibilities for the investigation of the fine structure of the ionosphere. (J.C.W.)

10165 METHOD OF DETERMINING THE HEIGHT DEPENDENCE OF THE VERTICAL DRIFT OF SMALL-SCALE INHOMOGENEITIES. Afraymovich, E. L. (Ionospheric Sector, Kazakh, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 471-3(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 553-4(1971).

The rate, v, of vertical drift of small-scale ionization inhomogeneities is determined in vertical sounding as $v = (\Delta h/\Delta f)(\Delta f/\Delta\tau)$, where $\Delta h/\Delta f$ is the vertically spaced base, corresponding to the spacing of operating frequencies Δf, and $\Delta\tau$ is the time shift (delay) between the fluctuations of the signal reflected from the ionosphere. The determination of the delay $\Delta\tau$ is analyzed by the correlation method. The method is followed and the assumptions are given to improve the time resolution in measurements of the rate of vertical drift. (J.C.W.)

10166 SUBSTORM IN AURORAS. Starkov, G. V.; Fel'dshtein, Ya. I. (Polar Geophysical Inst., Kola, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 478-9(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 560-1(1971).

The general characteristics of an auroral substorm are discussed. The space–time pattern of development of a substorm was shown. Main additions of the proposed pattern of an auroral substorm are given. A substorm develops in three phases: incipient, developmental, and recovery. The instant T = 0 in the former pattern corresponds to the beginning of the developmental phase. During the incipient phase auroral arcs move from $\phi' \sim 70°$ to $\phi' \sim 65$ to 67°. Discrete auroras of the polar-cap type disappear 10 to 30 min before the instant T = 0. The auroral band that moves toward the pole during the developmental phase leaves a considerable emission background after it. (J.C.W.)

10167 RELATIONSHIP BETWEEN GEOMAGNETIC FIELD VARIATIONS IN THE POLAR REGION AND IN THE MORNING–NIGHT SECTORS OF THE AURORAL OVAL. Afonina, R. G.; Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 485-7(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 567-9(1971).

Geomagnetic disturbances occur in the polar region, even when the geomagnetic field is absolutely quiet at middle and low latitudes. This indicates the existence in this region of an additional polar S_q^p variation superposed on the S_q^0 variation. The equivalent current system of S_q obtained for the antarctic summer from a recent experiment is characterized by condensation of the current at $\phi \sim 67$ to 70° on the morning and evening sides of the south polar cap. The distribution of the S_q field was reexamined for five quiet international days of the IGY summer. The determined field was interpreted as S_q^p + DP, DP being magnetic polar disturbances. The negative field vectors at $\phi \sim 70°$ in the morning were explained by the field of the western electrojet (DP) that is also present on international quiet days. By ascribing the decrease of the field in the morning to the effect of the eastern electrojet, only one eddy was obtained. It was located on the day side, but shifted toward the evening hours and explained both the decrease of the field at $\phi = 85°$ and its increase at $\phi \sim 70°$. Data from other experiments were analyzed to study the relationship with the auroral oval. (J.C.W.)

10168 MAGNETIC DISTURBANCES AND AURORAL LUMINOSITY. Osipov, N. K.; Pivovarov, V. G.; Pivovarova, N. B. (Radio Engineering Inst., Moscow. Inst. of Cosmophysical Investigations, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 487-9(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 570-1(1971).

The effect of various factors associated with the injection of auroral electrons on the variation of the ratio of the integral auroral luminosity as measured by an all-sky photometer to the magnitude of the magnetic disturbance is investigated. Although all-sky photometer records and magnetograms generally agree, particularly for slightly active visual forms and moderate magnetic disturbances, there are sometimes sharp differences between auroral luminosity records and magnetograms, indicating that even during moderate substorms the relationship in question may be complex because of the differences in the formation of auroral and magnetic activity in the presence of a single disturbance source. An expression is given and investigated for the ratio of auroral luminosity to the magnitude of the horizontal component of the magnetic disturbance. The fact that the rapid variations of the ratio, sometimes observed even during auroras that are not very active, are determined mainly by the variations of flux parameters can be regarded as established. (J.C.W.)

10169 EFFECT OF THE SEPTEMBER 22, 1968 SOLAR ECLIPSE IN THE F2 LAYER. Antsilevich, M. G.; Vilenskii, I. M.; Gerasimov, G. I.; (and others) (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Ionospheric Sector, Kazkh, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR. Gorky State Univ., USSR. Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 458-60(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 540-1(1971).

Vertical soundings were made between Sept. 15 to 30 in the Soviet Union to study the total solar eclipse of Sept. 22, 1968. Maps are shown for the center of the eclipse, the contours of the projections of the lunar half-shadow at a height of 300 km in the ionosphere, and the corresponding linear phases of eclipses of 90, 80, and 70%. Zones of negative disturbances are clearly visible; they follow with some lag the movement of the lunar shadow and half-shadow at ionospheric levels. The delay time of the reaction of the F2 layer to the maximum phase of the eclipse increased with increasing geomagnetic latitude during the solar eclipse of June 30, 1954, but the results in the Sept. 22 eclipse show that the higher the latitude, the shorter the delay time of the solar-eclipse effect. The solar-zenith angle apparently plays a major role here and so does the rate of recombination processes in the F2 layer. It is shown that, as the solar eclipse developed, the dimensions of the disturbed region and the intensity of the disturbance increased at first and then decreased again. The change in the dimensions of the disturbed region probably also depends on the solar-zenith angle. Recombination coefficients in the F2 layer were determined from the change in density at the layer maximum during the eclipse. (J.C.W.)

10170 HIGH-ENERGY ELECTRONS IN NEAR-EARTH SPACE. Grigorov, N. L.; Kalinkin, L. F.; Kogan-Laskina, E. I.; Savenko, I. A. (Moscow State Univ. Inst. of Cosmic Investigations, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 436-7(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 517-18(1971).

Data were analyzed from several experiments to identify high-energy flux in near-Earth space. Charged-particle fluxes revealed that the observed intensities exceeded several times the values ascribed to primary cosmic rays. Primary radiation near the geomagnetic equator was 80 to 120 m^{-2} sec^{-1} $ster^{-1}$ while the measured electron fluxes range from (3 to 5) × 10^2 m^{-2} sec^{-1} $ster^{-1}$. Geiger counters, used as detectors, showed that the flux of residual radiation is ~500 at the equator and 1000 m^{-2} sec^{-1} $ster^{-1}$ in the Murmansk area. An analysis of the traces of charged particle in an emulsion showed that the intensity of the recorded radiation exceeds by a factor of 3 the intensity of primary cosmic rays (during a single satellite revolution around the Earth). Experiments on Proton 1 and Proton 2 were performed to determine the energy spectrum of electrons at 200 to 600 km. Both in the stratosphere and at greater heights there are fluxes of electrons of high energies ($\leq 10^7$ eV). Direct albedo electrons in the stratosphere produce the injection of these particles into near-Earth space. Considerable temporal variations of secondary electron fluxes in the stratosphere, unrelated with the intensity variations of primary cosmic rays, can be regarded as evidence of the existence in near-Earth space of a reservoir where high-energy electrons accumulate. They precipitate into the atmosphere when the magnetosphere is disturbed. (J.C.W.)

10171 MODEL OF THE MAGNETOSPHERIC FIELD. Alekseev, I. I.; Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 480-2(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 562-4(1971).

A model is given of finding the magnetic field. Assuming the surface of the magnetosphere is given, the field is obtained by solving the magnetostatic problem. The linearity of magnetostatic equations simplifies the problem. The surface of the magnetosphere is approximated by a paraboloid of revolution, disregarding the difference between the equatorial and meridional cross sections of the magnetosphere. The fact that the radius of this surface increases on the nightside with distance from the Earth in proportion to $(R)^{1/6}$ does not lead to considerable errors if $R < 40\ R_E$ is confined, where R_E is the radius of the Earth. Previous models ap-

proximate the solution of the Chapman–Ferraro problem or substitute the field of surface currents by an imaginary dipole. The model developed here makes it possible to allow for the screening by the surface of the magnetosphere of various internal magnetic field sources (inclined dipole, current layer of the tail, ring current), which modifies significantly the field of the upper magnetosphere of the Earth. (J.C.W.)

10172 STRUCTURE OF THE GEOMAGNETIC FIELD AND CURRENTS IN THE MAGNETOSPHERE. Osipov, N. K.; Pavlov, E. E. (Yakutsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 483-5(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 565-6(1971).

The possible effect of currents on the structure of the magnetosphere and the formation of the characteristics of its current systems in relation to its structure are examined on the basis of experimental data. The distance to the magnetosphere boundary experiences regular UT variations that cannot be associated either with the effect of the slope of the geomagnetic dipole or with that of the nondipole part of geomagnetic field. An attempt was made to explain the effect by the longitudinal variations in the intensity of the ring current. Results show that it can be assumed that regular variations in the position of the magnetosphere boundary are the consequence of diurnal effects in the development of the ring current. The morphology of the separate injection of electron and proton fluxes into the auroral region is investigated. Separate injection of electrons and protons can be observed only in the presence of an efficient mechanism of charge separation in the magnetosphere. Therefore, regarding the variations in the energy characteristics of auroral particles, particle rigidity is known to increase upon transition from midnight to morning. This indicates the presence of a longitudinal structure in the magnetospheric electric field, probably associated with the uneven convective movements of the plasma that forms the cusp of the magnetosphere. (J.C.W.)

10173 CHARGED-PARTICLE ACCELERATION BY NONSTATIONARY ELECTRIC FIELDS IN EARTH'S MAGNETOSPHERE. Tverskaya, L. V. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 439-42(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 521-2(1971).

The existence of large-scale electric fields in the magnetosphere affects charged-particle dynamics, the fields generally thought to be associated with polar disturbances. Computations have shown the potential difference across polar electrojets to be about several tens of kilovolts for an average bay (with a magnetic-field disturbance under the jet of ~500 γ). The possibility of explaining the effects of fast-particle injection on low L shells by the Alfven mechanism (particle drift in the magnetic field of a dipole and in an electric field) has been suggested. Estimates with allowance for the possible amplitudes of electric fields agree with experimental data. A model is examined of a nonstationary electric field to establish the relation of its magnitude and duration and of the movement of particles along L to particle acceleration. It is assumed that the field varies as $E = E_0 \sin \tau$ and examines the movement of particles in this field when τ changes from 0 to 2π. (J.C.W.)

10174 PENETRATION OF SOLAR-WIND PROTONS THROUGH BOUNDARY OF EARTH'S MAGNETOSPHERE. Gurevich, A. V.; Shcherbakov, V. P. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 438-9(1971).

Translated from Geomagn. Aeron.; 11: No. 3, 519-20(1971).

The main component of the magnetospheric plasma responsible for the ring current and magnetic storms is protons with energies 5 to 50 keV. The flux of protons of these energies that penetrates into the magnetosphere is about 2% of the flux incident upon the magnetosphere boundary. A possible mechanism of penetration of solar-wind protons into the magnetosphere across its boundary is examined, and the problem of the penetration of protons through a plane boundary under the effect of a weak magnetic-field gradient is analyzed. Allowance for the effect on proton drift of the electric field and such factors as the curvature of the lines of force and the nonstationarity of the boundary only increases the proportion of penetrating particles. A large proportion of the particles will fall at a sharp angle upon the magnetosphere boundary and this will also reinforce the proton-capture effect. (J.C.W.)

10175 ROTATIONAL DISCONTINUITIES IN AN ANISOTROPIC PLASMA. Hudson, P. D. (Queen's Univ., Belfast). Planet. Space Sci.; 19: No. 12, 1693-9(Dec 1971).

A general theory of rotational discontinuities is developed, and the changes in the components of the plasma pressure, $p_{||}$ and $p_{\perp}$, and in the magnetic induction, B, are found. For a given value of $\lambda = (p_{||} - p_{\perp})\, 4\pi\mu/B^2$ upstream, only a limited range of downstream anisotropies are possible. If $\lambda > 0.6$ upstream, then isotropy is not possible downstream. Some special solutions are analyzed, and the identification of rotational discontinuities in the solar wind is discussed. (auth)

10176 DEACTIVATION OF N_2 $A\,^3\Sigma_u^+$ MOLECULES IN THE AURORA. Shemansky, D. E.; Zipf, E. C.; Donahue, T. M. (Univ. of Pittsburgh). Planet. Space Sci.; 19: No. 12, 1669-83(Dec 1971).

Recent rocket observations of the N_2 V–K (Vegard–Kaplan) system in the aurora were reinterpreted, using an atmospheric model based on mass-spectrometer measurements in an aurora of similar intensity at the same time of year. In contrast to the original interpretation, it is found that population by cascade from the $C^3\,\Pi_u$ and $B^3\,\Pi_g$ states in the $A\,^3\Sigma_u^+$ v = 0,1 levels, as calculated using recently measured electron excitation cross sections, accurately accounts for the observed relative emission rates (IV-K/$12PG_{0,0}$). In addition, there is no need to change the production rate of $A\,^3\Sigma_u^+$ molecules relative to that of $C^3\,\Pi_u$ v = 0 as a function of altitude in order to fit the profile of the deactivation probability to the atmospheric model. Quenching of $A\,^3\Sigma_u^+$ molecules at high altitudes is dominated by atomic oxygen. The rate constants for the v = 0 and v = 1 levels are 8×10^{-11} cm^3 sec^{-1} and 1.7×10^{-10} cm^3 sec^{-1}, respectively, as determined using the model atmosphere mentioned above. Recent observations with a helium-cooled mass spectrometer suggest that conventional mass-spectrometer measurements tend to underestimate the atomic oxygen relative concentration. The rate coefficients may therefore be too large by as much as a factor of 3. Below 130 km it is found that it is possible to account for the deactivation in bright auroras by invoking large nitric oxide concentrations, similar to those recently observed mass spectrometrically and using a rate constant of 8×10^{-11} cm^3 sec^{-1} for both the v = 1 levels. This rate constant is very nearly the same as that measured in the laboratory (7×10^{-11} cm^3 sec^{-1}). Molecular oxygen appears not to play a significant role in deactivating the lower $A\,^3\Sigma_u^+$ levels. (auth)

10177 ABSORPTION OF ELECTRONS IN ATOMIC OXYGEN. Dalgarno, A.; Lejeune, G. (Harvard Coll. Observatory, Cambridge Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Planet. Space Sci.; 19: No. 12, 1653-67(Dec 1971).

A detailed description is given of the energy degradation of energetic electrons absorbed in a weakly ionized gas of atomic oxygen that takes account of the discreteness of the energy losses through excitation. Graphs are constructed of the numbers of excitations to the various excited levels and of the numbers of ionizations that are produced when an energetic electron is absorbed in a gas with fractional ionization ranging from 10^{-6} to 10^{-2}. The results are briefly applied to atmospheric phenomena. (auth)

10178 TEMPERATURE ANISOTROPY AND ADIABATIC COOLING OF PROTONS IN THE SOLAR WIND. Eyni, M.; Kaufman, A. S. (Hebrew Univ., Jerusalem). Planet. Space Sci.; 19: No. 12, 1609-14(Dec 1971).

A simple theoretical expression for the mean kinetic temperature of the protons in a steady state as a function of heliocentric distance is derived. The basic assumption is that the temperature anisotropy of the protons is invariant in space where binary encounters are rare. For an assumed base temperature of 5×10^5 K at a distance of 0.05 AU, the calculated temperature at a distance of 1 AU is in the range (2 to 4) $\times 10^4$ K for an average anisotropy factor of 3: this range of temperatures is close to the observed average value under so-called "quiet" conditions. Measurement of the anisotropy factor at different heliocentric distances is required to test the basis of the model. (auth)

10179 SPECTRUM OF ELECTRON-CONTENT FLUCTUATIONS IN THE IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, New Zealand). Planet. Space Sci.; 19: No. 12, 1593-1608(Dec 1971).

Continuous records of the electron content of the ionosphere, from 1965 to 1970, are used to obtain power spectra covering periods from 30 sec to 2 yr at latitudes of 34 and 42°S. At periods up to 5 min, amplitudes were less than 0.2% of the total electron content. Variations produced by gravity waves were very common in the range 20 to 80 min, with no preferred periods. The rms amplitude per octave A_0 was about 10^{15} electrons/m^2, or 0.6% of the mean electron content. The amplitude increased during the day, particularly in winter when periodic components predominated. The cutoff of about 17 min was sharply defined, giving a mean scale height for the neutral atmosphere (at 300 km) of about 43 km in summer, 47 km on winter days, and 42 km on winter nights. From 12 hr to 1 month, A_0 was about 12% of the mean electron content in both summer and winter at 34°S, and 10% at 42°S. The 24-hr and 27-day peaks were largest just before sunspot maximum and almost disappeared near sunspot minimum. Variations between 1 and 27 days reflect the random occurrence of ionospheric storms and show no consistent peaks. Day-to-day and

night-to-night variations were both about 10% of the background content for periods from 2 days to 2 yr, apart from a slight decrease between 1 and 6 months. (auth)

10180 GEOMAGNETIC DISTURBANCE IN THE POLAR REGION OF THE ARCTIC DURING THE IQSY. Zhigalov, L. N. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 3, 490-1(1971). Translated from Geomagn. Aeron.; 11: No. 3, 572-4(1971).

The distribution of magnetic activity at polar stations in the Arctic during the IQSY on the basis of geomagnetic observations at observatories and drifting station North Pole 12 was examined for 1964. The intensity of magnetic disturbances is known to have a distinct geographic distribution and at arctic stations, the form of the diurnal magnetic activity pattern and its intensity do not remain constant even at stations at the same geomagnetic latitudes, but different longitudes. The general magnetic-activity level was much lower in 1964 than during the IGY. The form of the average monthly (seasonal) S_a at the stations in question remained generally the same as during the IGY, i.e., stations located at ϕ = 75 to 78° and Λ' = 320 to 60° had two maxima, a morning-noon maxima and one at night. Stations located at the same latitudes but at Λ' = 130 to 170° had three maxima, in the morning, at noon, and at night. The distribution and analyses of the maxima are given. (J.C.W.)

10181 EXTENSION OF LAGRANGE'S METHOD TO CERTAIN SYSTEMS OF FIRST-ORDER PARTIAL DIFFERENTIAL EQUATIONS. Chen, W. M.; Harris, R. D.; Watson, J. D. (Utah State Univ., Logan). J. Atmos. Terrest. Phys.; 34: No. 1, 159-64 (Jan 1972).

A modification of the method of characteristics was developed to solve systems of first-order hyperbolic partial differential equations where the characteristic curves are essentially identical. This method is applicable to fluid mixtures whose component fluid velocities are the same. Techniques were developed to find the solutions at desired points in space and time and to handle the conditions at the boundaries. Results of the application of this method to the solution of ion-density distributions in the Earth's ionosphere are illustrated. (auth)

10182 BEHAVIOR OF AURORA AT A MIDLATITUDE STATION. Dandekar, B. S. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 1, 127-38(Jan 1972).

The 6-yr study of aurorae from a midlatitude station, Sacramento Peak, New Mexico shows that these aurorae exhibit a good correlation with solar activity as regards recurrence and phase of the solar cycle. These aurorae show enhancement in brightness, occurrence frequency, and equatorward movement with increase in magnetic activity. These phenomena are similar to those of visual aurorae of the auroral zone, affirming that the midlatitude aurora is a wider but weaker manifestation. (auth)

10183 BREMSSTRAHLUNG IN THE ATMOSPHERE. Berger, M. J.; Seltzer, S. M. (National Bureau of Standards, Washington, D. C.). J. Atmos. Terrest. Phys.; 34: No. 1, 85-108 (Jan 1972).

Calculations pertaining to the emission of bremsstrahlung by electrons in the upper atmosphere are described, and the penetration of this radiation to atmospheric depths of 3 to 10 g cm^{-2} where it can be measured by balloon-borne detectors is discussed. The calculations take into account the multiple scattering and slowing down of electrons and the multiple Compton scattering and photoelectric absorption of bremsstrahlung photons. Numerical data were generated for electron beams incident onto the atmosphere with energies between 20 keV and 2 MeV, assuming wide-area precipitation and an incident angular distribution isotropic over the downward hemisphere. The results relate the number and energy spectrum of the incident electrons to the bremsstrahlung flux spectrum at balloon heights. The interpretation of some observed bremsstrahlung flux spectra is attempted. (auth)

10184 DAY-TO-DAY VARIABILITY OF THE QUIET-DAY DAILY RANGE OF EQUATORIAL GEOMAGNETIC FIELD AND ITS RELATIONSHIP WITH IONOSPHERIC DYNAMICS. Kane, R. P. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys.; 34: No. 1, 73-84(Jan 1972).

To study the day-to-day variability of the daily range $\Delta H = H_{max} - H_{min}$ of the H component of geomagnetic field at the equator, quiet days (A_p = 0 to 8) in the Quiet-Sun year 1964 were divided into four ranges viz. 0 to 69 gamma, 70 to 89 gamma, 90 to 109 gamma, and 110 or more gamma of ascending ΔH values at Trivandrum for the three seasons J, D, E separately. Average daily-variation patterns of several parameters for these 12 groups were studied. It was found that enhanced ΔH at Trivandrum was well correlated with the northern Sq-current strength only in winter when the latter was weak. ΔH at Trivandrum was poorly correlated with ΔH at Alibag as also with solar-radiation parameters (10.7 cm and x-ray fluxes) in all seasons, and moderately correlated with the southern component of interplanetary magnetic field B_x. In contrast, ΔH at Alibag was moderately correlated with the B_x and B_y components. Several other peculiarities of corresponding ΔY and ΔZ components and associated upheavals in ionospheric F-region parameters at equatorial and middle latitudes are presented and discussed. It is concluded that the day-to-day variability of ΔH at equatorial and middle latitudes is primarily associated with ionospheric upheavals which seem to be connected with different interplanetary parameters for different latitudes. (auth)

10185 MAGNETOGASDYNAMIC INTERACTIONS OF THE SOLAR WIND WITH PLANETARY BODIES. Sousk, Stephen Frederick. College Park, Md.; Univ. of Maryland (1971). 140p. University Microfilms Order No. 72-1693.

Thesis.

Interactions of the solar wind with planetary bodies based upon magnetogasdynamics are investigated. The flow is taken to be steady and inviscid. When the magnetic field has a component perpendicular to the velocity, induced magnetic fields may significantly affect the flow. New solutions were developed of the frozen-flow equations in which the magnetic field is perpendicular to the velocity. These solutions illustrate physical features of frozen-flow boundary-value problems in a mathematically tractable way. One solution illustrates enhancement of the magnetic field near the stagnation point when there is frozen flow around a nonporous obstacle. A second solution illustrates magnetogasdynamic flow against an obstacle porous to solar wind. Solar-wind interactions with a body porous to it is considered, such as occur at Mars and Venus. The analysis includes the region near the subsolar point in which the Alfvén Mach number is less than unity; this region is usually neglected because of mathematical complexity. A solution is developed along the stagnation streamline for frozen flow against a sphere. Close to the ionopause of Mars and Venus, the solar-wind density is less than the density immediately downstream of the bow shock. The stagnation streamline solution is useful in providing the initial conditions for solar-wind flow into a planetary atmosphere. (TSS) (Diss. Abstr. Int., B)

10186 SPECTRUM OF THE AIRGLOW. Ingham, M. F. Sci. Amer.; 226: No. 1, 78-85(Jan 1972).

Since the photochemical processes that cause the airglow depend critically on conditions of illumination, there are marked differences between the three forms of airglow. Nightglow is mainly discussed here, but features peculiar to the twilightglow and dayglow are also described. The fluorescence band of N_2^+ at 3914 Å, produced when N_2 is ionized and excited by x-ray-produced electrons, has been used for detection of nuclear weapons and its observation might serve to record cosmic events, e.g., supernova explosions, that generate x rays in large quantities. (L.M.T.)

10187 PROPAGATION OF 1- TO 10-MeV SOLAR FLARE PROTONS IN INTERPLANETARY SPACE. Murray, Stephen S. Pasadena, Calif.; California Inst. of Tech. (1971). 227p. University Microfilms Order No. 72-479.

Thesis.

Observations of 1- to 10-MeV solar-flare protons associated with the June 7, 1969 solar event were used in an investigation of the physical processes affecting particle propagation in interplanetary space. The observations were made with the Caltech Solar and Galactic Cosmic Ray Experiment on board OGO VI, a low-altitude polar-orbiting satellite. It was found that, during the decay of the event, the physical processes of diffusion, convection, and energy change must all be considered to obtain satisfactory agreement between the observations and theoretical predictions. In particular, it was found for this event that there is clear evidence for energy-change processes occurring in interplanetary space. The observed energy change is not due simply to adiabatic deceleration in a uniformly expanding solar wind. During the decay of this event the effects of diffusion are consistent with an energy-independent diffusion coefficient $\kappa_{||}$ from 1 to 10 MeV with a value of approximately 5×10^{20} cm^2/sec. (Diss. Abstr. Int., B)

10188 COLLISIONLESS-ION-BEAM PLASMA. Freeston, I. L. (Univ. of Sheffield, Eng.); Gardiner, G. W.; Zavody, A. M. J. Phys., E (London); 5: No. 1, 19-23(Jan 1972).

A laboratory plasma of density of the order of 3×10^{12} electrons/m^3, electron temperature 0.15 eV, mean free paths greater than 1 m, and which was designed to simulate the ionospheric plasma, is described. The plasma is formed by neutralizing an ion beam with electrons, the ions and electrons being produced from separate thermionic sources. Typical results obtained with

a single electrode probe are interpreted by the standard Langmuir procedure, and show that the measured density agrees with the measured plasma frequency from measurements of the admittance of a parallel-grid capacitor. The plasma is undisturbed by the application of a magnetic field, and is compared with the ionospheric plasma. (auth)

Low-Temperature Physics and Cryogenic Equipment

Refer also to abstract 9796.

Superfluidity

10189 SPECIFIC HEAT MAXIMA OF ^{4}He FILMS. Moore, M. A. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 37A: No. 4, 345-6(6 Dec 1971).

In thick films of ^{4}He, the bulk-liquid λ transition is rounded into a broad maximum. The variation of this maximum with film thickness is calculated and found to agree with experiment. (auth)

10190 GROWTH OF ^{3}He LAYERS FROM SURFACES OF NEARLY SATURATED SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. Saam, W. F. (Ohio State Univ., Columbus). Phys. Rev., A; 5: No. 1, 335-8(Jan 1972).

The problem of the growth of the ^{3}He phase from a free surface of a nearly saturated solution of ^{3}He in superfluid ^{4}He at zero temperature is considered. Using a Fermi-liquid theory modified to account for the finite thickness of the ^{3}He phase by introducing a distortion of the Fermi surface, it is found that the number of ^{3}He layers N_L in the ^{3}He phase increases as the ^{3}He chemical potential μ_3 approaches its bulk value μ_3^0 as $N_L \sim (\mu_3^0 - \mu_3)^{-\frac{1}{4}}$. This prediction is in agreement with recent experimental results of Guo, Edwards, Sarwinski, and Tough. (auth)

10191 TWO-FLUID MODEL OF THE HELIUM FILM. Goodstein, D. L.; Saffman, P. G. (California Inst. of Tech., Pasadena). Proc. Roy. Soc. (London), Ser. A; 235: No. 1563, 447-68(7 Dec 1971).

Following the recent discovery that the thickness of a helium film is independent of its state of superflow, the conditions under which the two fluid model is consistent with equilibrium between film and vapor were analyzed. The experimental result is found to be a natural consequence of the requirements for equilibrium. In addition, it was found that waves in a moving film should be convected at approximately $\frac{1}{2}(\rho_s/\rho)u_s$, where u_s is the superfluid velocity. A new criterion for critical velocity is discovered and a new result is obtained for the attenuation of waves. (auth)

10192 CONNECTION BETWEEN A MICROSCOPIC AND THE PHENOMENOLOGICAL THEORY OF SUPERFLUIDITY. Haug, H.; Weiss, K. (Philips Research Labs., Eindhoven, Netherlands). Lett. Nuovo Cim.; 2: No. 17, 887-90(23 Oct 1971).

An attempt is made to develop a hydrodynamic theory of superfluid helium by treating the system of equations of motion for the reduced density matrices. For the reduced one-particle density matrix, R_1, off-diagonal long-range order is assumed. The macroscopic wave function and the incoherent part describe the condensate and the depletion, respectively. In order to decouple the hierarchy of equations of motion, the two-particle reduced density matrix, R_2, is partly expressed in terms of products of R_1. The unfactorized part of R_2 is neglected. Anomalous functions are not considered. From the equation of motion for R_1, hydrodynamic equations for the condensate and depletion densities and velocities and the internal kinetic energy density tensor, T_{ik}, are obtained. These functions, defined in terms of the macroscopic wave function and the incoherent part, are shown. In the equation of motion for T_{ik}, an internal energy flux tensor appears. This quantity is put equal to zero in order to close the set of hydrodynamic equations. Variations on a microscopic scale, which are described by spatial third-order derivatives are neglected, and the internal kinetic-energy density tensor is assumed to be diagonal. From this set of hydrodynamic equations, the conservation laws are constructed for the total density, the momentum density, and the total energy density, which is given by the expectation value of the Hamiltonian density. The developed theory shows explicitly how Bose condensation is linked with the phenomenological theory of superfluidity. However, due to the rough treatment of the potential (Taylor expansion) and the neglections in R_2, a quantitative comparison with the experimental data for helium II is not possible, even in the neighborhood of the transition temperature. (M.H.R.)

10193 HYDRODYNAMIC APPROACH TO THE ROTON-LIMITED MOBILITY OF IONS IN LIQUID HELIUM. Doake, C. S. M.; Gribbon, P. W. F. (Univ. of St. Andrews, Scotland). J. Phys., C (London); 4: No. 16, 2457-65(18 Nov 1971).

The mobilities of positive and negative ions were measured in liquid helium in the temperature range 0.9 to 1.0°K as a function of electric field. Within the limits of accuracy of 3%, the mobilities were fitted to a hydrodynamic theory for the interaction of the ions with rotons in the normal fluid component of He II. A drop in mobility with velocity is predicted. Both these results and those of Schwartz (1969) can be fitted to the theory. The theory contains one adjustable constant. This constant links the variation of ion drift velocity to the velocity field of the superfluid, which is responsible for producing an excess roton distribution around the ion, and it relates a macroscopically observed velocity to the microscopic process of momentum loss by the ion. The results show also no clear evidence for periodic discontinuities in mobility and the theory does not require their existence. (auth)

10194 DISSIPATION IN THERMALLY DRIVEN LIQUID HELIUM II FILM FLOW. Liebenberg, Donald Henry. Madison, Wis.; Univ. of Wisconsin (1971). 79p. University Microfilms Order No. 71-25,484.

Thesis.

The development of dissipation at increasing flow velocities in a liquid helium II film was measured in the temperature range 1.7 to 2.1 K. Sensitive-resistance thermometers of superconducting aluminum films were developed. These minimize both the perturbation to the flow pattern in the helium film and the Kapitza-resistance effects. Measured dissipation values increase more rapidly with increasing velocity than is predicted by the Gorter and Mellink theory. Within the range of measured dissipation values, no evidence is found to support the concept of a critical velocity flow transition from pure potential flow to dissipating flow. The data are shown to be consistent with the thermal fluctuation theory advanced by Langer and Fisher provided the dissipation occurs as a result of vortex ring production. (Diss. Abstr. Int., B)

10195 TUNNELING FROM ELECTRONIC BUBBLE STATES THROUGH LIQUID/VAPOR INTERFACE OF He II. Rayfield, G. W.; Schoepe, W. (Univ. of Oregon, Eugene). Phys. Lett.; 37A: No. 5, 417-18(20 Dec 1971).

A model is presented which shows that electrons escape through the free surface of He II by tunneling from electronic bubble states. The results give a bubble radius of 12.9 Å and a binding energy of 0.72 eV for the electronic bubble. (auth)

10196 FLUCTUATIONS AND SUPERFLUIDITY IN FINITE SYSTEMS. Pathria, R. K. (Univ. of Waterloo, Ont.). Phys. Lett.; 37A: No. 5, 423-4(20 Dec 1971).

Considerations of the density fluctuations and the ground-state occupancy of a finite Bose–Einstein system lead to a workable criterion for the onset of superfluidity. The criterion is applied to thin films and narrow channels. (auth)

10197 HELIUM 4. Galasiewicz, Zygmunt M. Commonwealth and International Library. Selected Readings in Physics. Elmsford, N. Y.; Pergamon Press, Inc. (1971). 344p. $9.50.

The history of helium 4 is traced from its discovery in 1868 in the Sun's atmosphere through the development of a microscopic theory of superfluidity. Nineteen experimental and theoretical papers published between 1924 and 1956 are represented here. (M.H.R.)

Superconductivity

Refer also to abstracts 9687 and 10479.

10198 (BNL–16267) SOME PROPERTIES OF TRANSITION METAL SUPERCONDUCTORS AT SURFACES AND IN THIN FILMS. Strongin, Myron (Brookhaven National Lab., Upton, N. Y.). [1971]. 14p. (CONF-711108–9). Dep. NTIS.

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Low energy electron diffraction (LEED) and Auger spectroscopy measurements on Nb surfaces are described and the results are related to some of the problems encountered in the design of superconducting rf cavities. Possible protective coverings for the Nb surfaces that are used in these cavities are discussed, and experiments on one type of covering, i.e., thin layers of Nb_3Sn grown on Nb, are described. Finally, experiments on amorphous transition metal films are presented and the results of the measurements are discussed in the context of LEED measurements of θ_D at the niobium surface. (auth)

10199 (NP–19140) I. ISOTOPE EFFECT OF THE SUPERCONDUCTORS CADMIUM, MOLYBDENUM, AND ZIRCONIUM.

II. THE PRESSURE EFFECT OF SEVERAL SUPERCONDUCTING ELEMENTS. Diss. Nr. 4546. Palmy, Claudio (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1970. 70p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

Investigations on the isotope effect of the superconductors Zr, Mo, and Cd are reported. The experimental results show a vanishing isotope effect in Zr and an intermediate one in Cd and Mo. These deviations from the normal isotope effect are well understood within the framework of the BCS theory if the Coulomb repulsion is included in the effective interaction. (auth)

10200 (TID-25864) A STUDY OF SUPERCONDUCTIVITY IN FAST FROZEN (SPLAT-COOLED) INDIUM-GALLIUM ALLOYS (INCLUDING A CRITICAL ANALYSIS OF THE A.C. SUSCEPTIBILITY FOR STUDYING NORMAL PROPERTIES OF METALS). Carroll, Paul J. (Georgetown Univ., Washington, D. C.). Jun 1971. 228p. Dep. NTIS.

Thesis.

The superconducting properties of seven fast frozen (77°K) In–Ga samples of varying indium concentration (0 to 10% by weight) were studied, using ac susceptibility, dc magnetization, and specific-heat-capacity methods. The measurements indicate that, above 0.25% In, a small volume of the sample becomes superconducting near T_c of indium (3.4°K), but bulk superconductivity does not occur until $T = T_c$ of gallium (1.08°K). Microprobe analysis measurements show that the indium and gallium are homogeneously distributed with the indium in clumps less than a micron in size and separated by an average distance less than one micron. Several models of superconductivity for the In–Ga system were analyzed, using the superconductivity data. All of the models fit some features of the data, but only the model of an array of small superconducting In–Ga loops with gallium enhanced by a proximity effect is consistent with all the measurements. However, the agreement for the proximity-effect model is not strong enough to consider the model as unique. The resistive-component behavior of In–Ga and pure single-crystal gallium samples in ac magnetic fields was also studied. A peak in the resistive component of emf from a coil surrounding a sample in an ac magnetic field was observed in In–Ga, pure gallium, and other materials. This peak, which has sometimes been observed near T_c and associated with superconductivity, was identified as a normal-state skin-depth effect caused by a spatial variation in phase of penetrating ac fields. The temperature, T_p, at which the peak occurs was calculated for resistively isotropic and anisotropic materials. For isotropic materials, the resistive peak occurs when $R/\delta = 2$, where R is the sample radius and $\delta = (2\rho/\mu_0\omega)^{1/2}$ is the normal state skin depth. The variation of T_p with frequency was measured in single-crystal gallium samples. The values of T_p agree quite well with T_p calculated using the anisotropic model. The shape of the resistive peak data also fits the shape calculated by the anisotropic model if an anomalous skin effect is assumed at low temperatures. Evidence of anomalous behavior at low temperatures is presented. Measurements of $T_p(\omega)$ for a single-crystal gallium sample show that $\ln \rho_{peak} \sim \ln \omega_{peak}$ for both measured $T_p(\omega)$ and $T_p(\omega)$ calculated using the anisotropic model. This proportionality relation between $\ln \rho(T)$ of gallium reported in the literature and $\ln \omega_{peak}$, both measured and calculated, suggests that the temperature variation of the resistivity of a material may be calculated to within a constant from measurements of T_p as a function of frequency. (auth)

10201 (TID-25866) SUPERCONDUCTIVE ENERGY GAP OF GALLIUM AS A FUNCTION OF CRYSTAL ORIENTATION. Straus, Leon Stephan (Georgetown Univ., Washington, D. C.). Jul 1971. 183p. Dep. NTIS.

Thesis.

The energy gap versus crystal orientation in the gallium AB plane was obtained from many single crystal high impedance $Ga/Ga_xO_y/Pb$ tunnel junctions. The I–V characteristics can be correlated with the local anisotropy of the energy gap and the Fermi surface characteristics. In certain crystal directions (32, 36, 61.5, and 70° in the AB plane and along the c axis), multiple energy gaps were observed. These multiple energy gaps appear to correspond to simultaneous tunneling into two different gallium Fermi surfaces. The anisotropy of the gallium energy gap was observed to be about 5% in this plane, a value that is low when compared to other estimates of the anisotropy taken on the bulk of the material. These data, along with the data of Yoshihiro and Sasaki, were used to examine the tunneling selection rules for gallium in light of the discussions of Dowman, MacVicar, and Waldram. The best fit of the data to the Fermi surface characteristics is obtained when tunneling is assumed to occur in a direction normal to the crystal surface. (auth)

10202 CORRELATION EFFECTS OF THE SUPERCONDUCTING TYPE IN π-ELECTRON SYSTEMS. Kresin, V. Z. (Moscow State Pedagogical Inst.). Zh. Eksp. Teor. Fiz.; 61: No. 3, 989-1001(Sep 1971). (In Russian).

Pair correlation effects of collectivized π electrons in complex molecules are investigated. Various attraction mechanisms as well as the dependence of the electron spectrum on parity of number of electrons are discussed. The behavior of a π-electron system in external electric and magnetic fields (anomalous diamagnetism, polarizability, etc.) is investigated. Collective excitations and the multiplet spectrum structure are considered. (auth)

10203 DC AND AC JOSEPHSON EFFECT IN SPUTTERED $Nb-NbO_x-Pb$ JUNCTIONS. Schwidtal, K. (Inst. for Exploratory Research, Fort Monmouth, N. J.). J. Appl. Phys.; 43: No. 1, 202-8(Jan 1972).

The magnetic field dependence of the maximum dc Josephson current and of the ac Josephson-effect-induced step structure have been measured for sputtered $Nb/NbO_x/Pb$ Josephson junctions, and found to be in very good agreement with theoretical predictions; even for junctions made with dirty Nb thin films. From this agreement it is concluded that the observed anomalies in the I–V characteristics, namely, excess currents for voltages $\Delta(Pb) < V < \Delta(Pb) + \Delta(Nb)$ and a "knee" in the I–V curve at voltages just above $\Delta(Pb) + \Delta(Nb)$, cannot be attributed to nonuniformities in the plane of the junction. It is further shown that these anomalies, especially the "knee," can be explained by a proximity-effect model in which the surface of the Nb thin film is assumed to be gapless due to gaseous impurities. The junctions were found to be much more stable with respect to repeated-thermal cycling and storage at room temperature than $Pb/PbO_x/Pb$ junctions made under the same conditions. (auth)

10204 JOSEPHSON TUNNELING BARRIERS BY rf SPUTTER ETCHING IN AN OXYGEN PLASMA. Greiner, J. H. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 42: No. 12, 5151-5(Nov 1971).

A new technique for fabricating Josephson tunneling barriers was developed. Oxide tunnel barriers with estimated thicknesses from 20 to 50 Å were formed on lead films with indium underlayers and on niobium films. The technique includes an rf-sputter etching step in argon for cleaning followed by an rf sputter etching step in oxygen. During the latter, an oxide film is grown having a steady-state thickness which is attributed to a balance between sputtering and oxidation rates. Different oxide thickness may be obtained by varying process parameters such as oxygen pressure and rf power. (auth)

10205 HYSTERESIS EFFECTS IN THE SUPERCONDUCTING Pb–Tl ALLOY SYSTEM. Dubeck, L. W. (Temple Univ., Philadelphia); Rao, C. T.; Rothwarf, F. J. Appl. Phys.; 42: No. 12, 5196-7(Nov 1971).

Previously, the Pb–In alloy system was studied, and a method of transforming hysteretic magnetization curves into their corresponding reversible curves was published. Some magnetization curves for Pb–Tl alloys were re-analyzed in the same manner. The analysis strongly suggests that there is, in fact, no maximum in $H_c(0)$ as a function of thallium concentration in the Pb–Tl system. It is believed that the maximum observed in $H_c(0)$ is due to composition-dependent hysteresis effects similar to those seen in the Pb–In system. (M.H.R.)

10206 SUPERCONDUCTOR COILS. (to Siemens Aktiengesellschaft). British Patent 1,255,265. 1 Dec 1971. Priority date 6 Mar 1968, Germany.

The superconducting coil described contains at least two coaxial series-connected disc windings. Each winding is made up of a composite conductor strip containing a plurality of separate filamentary superconductive cores extending adjacent to one another and connected in parallel at the coil ends. The cores are embedded in stabilizing metal of good normal conductivity and insulated laterally from one another between the coil ends. Each electrical loop is defined by two of the superconductive cores and their mutual end-connecting points are so arranged that substantially no net radial magnetic flux links the electrical loop as a whole. The net voltage induced around the electrical loop by changes in radial magnetic flux components on energization or de-energization of the coil is, therefore, substantially zero. (M.H.R.)

10207 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTING ELECTRICAL CONDUCTORS. Caslaw, James Sabeston (to Plessey Co. Ltd.). British Patent 1,254,542. 24 Nov 1971. Filed 20 Feb 1968.

A process is described for the production of wire or tape for use, for example, in superconducting electromagnets and consisting of a Sn–Nb alloy containing up to 5 wt. % Zr. As usually carried out, formation of the Nb–Sn alloy is a slow process even at elevated temperatures. The method described is claimed to be quicker. Niobium wire or tape, having a Zr content to provide an

O_2 content of 500 to 5000 ppm in at least a surface layer, is given a Sn deposit, and the O_2-containing material is then heat treated to produce the superconducting alloy. The O_2 content may be established in a preheating stage in the appropriate atmosphere before the tinning operation. The O_2 addition to the tape may alternatively be effected by surface oxidation, such as by an electrolytic oxidation process, followed by heating to cause the O_2 to diffuse into the tape. (UK)

10208 SYSTEMATIC DISCREPANCY BETWEEN THIN FILM MAGNETIC TRANSITIONS AND SUPERCOOLING IN Al, In, Sn, AND Pb. Cody, G. D. (RCA Labs., Princeton, N. J.). Phys. Lett.; 37A: No. 4, 295-6(6 Dec 1971).

Recent measurements permit a comparison between values of the Ginzburg–Landau parameter deduced from thin-film measurements and values obtained from supercooling. The large and systematic discrepancies existing between the two measurements are ascribed to nonlocality. (auth)

10209 SUPERCONDUCTING SOLENOID AT 1.6 TO 5.2°K. Lazarev, B. G.; Lazareva, L. S.; Goridov, S. I. (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 199: No. 5, 1044-7(11 Aug 1971). (In Russian).

The behavior of superconducting solenoids with fields of 74,000 oersteds was investigated over the temperature range 1.6 to 5.2°K. The solenoids were wound with wire composed of 60 at. % Ti–40 at. % Nb and 50 at. % Nb–25 at. % Ti–25 at. % Zr. Critical current in these solenoids was determined as a function of temperature. It is concluded that superconducting solenoids with large fields can operate successfully both below and above 4.2°K, at least to the critical temperature of He, 5.2°K. (K.S.W.)

10210 WAVE CHARACTER OF THE TIME DEPENDENT GINZBURG–LANDAU EQUATION AND THE FLUCTUATING PAIR PROPAGATOR IN SUPERCONDUCTORS. Ebisawa, Hiromichi (Tokyo Univ.); Fukuyama, Hidetoshi. Progr. Theor. Phys. (Kyoto); 46: No. 4, 1042-53(Oct 1971).

The time dependent Ginzburg–Landau equation and the fluctuation propagator of a superconductor in a static electromagnetic field are examined to the next order of the small parameters $1/\epsilon_F\tau$ and T/ϵ_F, where ϵ_F is the Fermi energy and τ the relaxation time. The coefficient of the time derivative of the order parameter becomes a complex number, whose imaginary part is of order of T/ϵ_F smaller than the real part. This term is shown to be important for the Hall effect due to the fluctuation near T_c, which has not been expected in the usual approximation. The arguments cover the cases of arbitrary mean free paths near T_c and of arbitrary temperatures except $T \ll T_c$. (auth)

10211 SUPERCONDUCTIVITY AND MAGNETIC SUSCEPTIBILITY STUDIES OF THE CUBIC LAVES–PHASE ALLOYS $CeRu_{2-x}Co_x$. Smith, T. F. (Univ. of California, San Diego, La Jolla); Luo, H. L.; Maple, M. B.; Harris, I. R. J. Phys., F (London); 1: No. 6, 896-901(Nov 1971).

Measurements of the room temperature lattice parameter, the superconducting transition temperature, and the magnetic susceptibility over the temperature range 1.5 to 300°K were made on the pseudobinary alloy system $CeRu_{2-x}Co_x$. T_c is depressed from values for the terminal compounds, and superconductivity could not be detected above ~0.33°K for $0.2 < x < 1.7$. From the form of the variation of T_c with Co substitution and the susceptibility measurements, it is concluded that the destruction of the superconductivity in $CeRu_2$, is due to localized spin fluctuations associated with the Co. The effects of transition-metal and rare-earth substitution into $CeRu_2$ are compared and discussed. (auth)

10212 SUPERCONDUCTIVITY OF AlMn AND ThU ALLOYS UNDER PRESSURE. Huber, J. G.; Maple, M. B. (Univ. of California, San Diego, La Jolla). J. Phys., F (London); 1: No. 6, 893-5(Nov 1971).

The depression of the superconducting transition temperature (T_c) of AlMn and ThU alloys decreases with pressure. To the extent that localized spin fluctuations are responsible for the depression of T_c in these alloys, it is inferred that the lifetime of the spin fluctuations decreases with pressure. (auth)

10213 LINEAR ELECTRODYNAMICS OF SUPERCONDUCTING FILMS OF FINITE WIDTH. Likharev, K. K. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 909-18(1971). (In Russian).

The linear electrodynamics of strips of a thin superconducting film is considered. The current distribution in such strips is found. The energetic relations and equivalent circuits were obtained. It is shown that rather narrow film strips are necessary in order to realize the effective superconducting nonlinear reactive elements for uhf systems. (auth)

10214 FORMATION OF A MIXED STATE IN PLANE SUPERCONDUCTING FILMS. Likharev, K. K. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 919-25(1971). (In Russian).

The formation of a mixed state in plane thin superconducting films under the action of an external field and current is considered. It is shown that due to entering the fluxes with the axes normal to the film plane, the mixed state forms at rather small values of the fields and currents. The relations between the fields at which the fluxes enter the film and at which the Ginzburg–Landau type nonlinearity takes place are described. (auth)

10215 COLLECTIVE MODES, COUPLING CONSTANTS, AND DYNAMICAL-SYMMETRY REARRANGEMENT IN SUPERCONDUCTIVITY. Cremer, S. (Technion–Israel Inst. of Tech., Haifa); Sapir, M.; Lurie, D. Nuovo Cim.; 6B: No. 2, 179-205 (11 Dec 1971).

A simplified approach to the field-theoretic treatment of superconductivity is developed. In addition to providing more clear derivations of known results, some new results are derived: expressions for the coupling constants of the Goldstone mode and the plasmon to the quasi particles. The formalism also provides a greatly simplified method for determining the specific form of current operators in terms of physical fields. This is based on the familiar fact that the matrix element of an operator density between physical states can be computed by coupling the operator density to an external c-number field and evaluating the lowest-order transition amplitude induced by the field. (auth)

10216 ANOMALOUS SUPERCONDUCTORS WITH OVERLAPPING ZONES. Geilikman, B. T.; Masharov, N. F. Fiz. Metal. Metalloved.; 32: No. 3, 492-8(Sep 1971). (In Russian).

The behavior of multizone superconductors with strong coupling was investigated. Special features of Cooper pairing in such systems are discussed. Thermodynamic quantities are evaluated. The yield beyond the limits associated with the approximation of weak coupling leads to essential peculiarities in the behavior of superconductors with overlapping zones at temperatures close to zero or to the critical. (tr-auth)

10217 VORTEX MOTION AND THE JOSEPHSON EFFECT IN SUPERCONDUCTING THIN BRIDGES. Likharev, K. K. Zh. Eksp. Teor. Fiz.; 61: No. 4, 1700-11(Oct 1971). (In Russian).

The dependence of processes occurring in superconducting bridges on the relation between their dimensions and parameters of the bridge material is considered theoretically. It is shown that the Josephson effect in the bridges also arises when the bridge length is greater than the coherence length, and the current density in it does not depend uniquely on the wave function phase difference between the bridge ends. (auth)

10218 INTERMEDIATE STATE OF A HOLLOW CURRENT-CARRYING SUPERCONDUCTOR. Tekel, P. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1691-9 (Oct 1971). (In Russian).

The problem of destruction of superconductivity of a hollow cylindrical sample by an electric current is solved. The structure of the intermediate state that arises in this case is elucidated. It is shown that a range of current values exists in which Gorter structures may exist. The critical current values and sample resistance are calculated by taking into account the finite period of the structure. (auth)

10219 CRITICAL SUPERCONDUCTOR CURRENT IN A PARALLEL FIELD. Zaitsev, R. O. Zh. Eksp. Teor. Fiz.; 61: No. 4, 1620-6(Oct 1971). (In Russian).

The maximal critical current density is calculated (1) in the presence of a rigid disordered vortex system; (2) in the presence of an ordered but strongly fixed lattice; and (3) near a second critical field. The results are obtained at both zero temperature and temperatures near the critical value. The theory can be compared with the experiments when the critical current is the same as the maximal and when it is proportional to the cross section of the sample. In these cases qualitative and, in some cases, quantitative agreement with the experiments is observed. The calculations are carried out by the self-consistent field method. (auth)

10220 SUPERCONDUCTING CURRENT IN WIDE s–n–s CONTACTS. Svidzinskii, A. V.; Antsygina, T. N.; Bratus, E. N. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1612-19(Oct 1971). (In Russian).

Weak superconductivity in an s/n/s contact is investigated. The ordering parameter Δ in the model is assumed to be constant throughout the superconductors; in the normal metal Δ is assumed to equal 0. The expression for the Green function of the system is

found by two different methods. Contributions of the discrete- and continuous spectra states to the Green function are summed up exactly. The critical current through the s/n/s contact is calculated in the whole range of temperatures for contacts with the width $d \gg \xi_0$. (auth)

10221 SUPERCONDUCTIVITY IN THE TWO-BAND MODEL WITH DIFFERENT EFFECTIVE MASSES. Kopaev, Yu. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1591-9(Oct 1971). (In Russian).

In the two-isotropic-band model with almost equal carrier concentrations and strongly differing masses, both the electron–hole scattering amplitude and electron–electron scattering amplitude for different bands possess logarithmic singularities. The total scattering amplitude for carriers from different bands can be expressed in terms of a "parquet" diagram. As for a one-dimensional metal the ground state is not characterized by pairs of particles but by groups of four particles near the Fermi surface. The charge of the four particles is twice the electron charge. Such solutions exist for an arbitrary sign of interaction, i.e., for both repulsive and attractive interaction between carriers from different bands. The sign of the interaction determines the spin structure of the four particles. (auth)

10222 OSCILLATION SPECTRUM OF CHARGED FLUX LINES. Baramidze, G. A. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 64: No. 2, 309-12(Nov 1971). (In Russian).

The oscillation spectrum of Abrikosov's flux line in Type-II superconductors was studied, using the microscopic model of charged Bose gas. It is shown that a single flux line can oscillate. The high-frequency branch of the oscillations is found. The quadratic law is found for the dispersion. (auth)

10223 FLUCTUATION-ENCHANCED DIAMAGNETISM IN SUPERCONDUCTORS ABOVE THE TRANSITION TEMPERATURE. Kurkijarvi, Juhani; Ambegaokar, Vinay (Univ. of Helsinki). Phys. Rev., B; 5: No. 3, 868-79(1 Feb 1972).

A theory that describes small-amplitude fluctuations of arbitrary spatial extent in a superconductor was used to calculate the magnetization in a magnetic field above the transition temperature. The calculations agree quite well with the experimental data. Analytical and numerical work indicates that corrections to the electromagnetic properties because of the large size of the fluctuating pairs play an essential role. The effect of impurity scattering was also included. For moderately small impurity concentrations, agreement is obtained with a semi-empirical suggestion due to Gollub, Beasley, and Tinkham that a universal behavior should occur in terms of an appropriately scaled magnetic field. Deviations from this behavior are predicted at higher impurity concentrations. (auth)

10224 BOSON METHOD IN SUPERCONDUCTIVITY: TIME-DEPENDENT THEORY. Leplae, L.; Mancini, F.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Phys. Rev., B; 5: No. 3, 884-94(1 Feb 1972).

The boson method in superconductivity, developed in previous articles, is extended in order to take into account time-dependent phenomena. Starting from the equations of motion for the Heisenberg electron field, a formulation of superconductivity is constructed in which gauge invariance and current conservation are implicitly satisfied. Previously it was shown how, by means of invariant transformations called boson transformations, a space-dependent order parameter, may be generated; in this way the space-dependent properties of a superconductor are described, and the problem of solving the Gor'kov equations is bypassed. In this article the concept of boson transformations is generalized by letting them generate a space- and time-dependent order parameter; in this way, a formulation of the theory of superconductivity is proposed in which space- and time-dependent effects are taken into account. As an illustration of the method, in the last part of this work a system consisting of two weakly coupled superfluid liquids is studied, and a theoretical explanation is given of the experimental fact that the system will present dynamical stability at the harmonics and subharmonics of a fundamental frequency. (auth)

10225 PAIR PROPAGATOR APPROACH TO FLUCTUATION-INDUCED DIAMAGNETISM IN SUPERCONDUCTORS: EFFECTS OF IMPURITIES. Lee, Patrick A.; Payne, Marvin G. (Yale Univ., New Haven). Phys. Rev., B; 5: No. 3, 923-31(1 Feb 1972).

Within the ladder approximation, expressions were obtained for the electron pair propagator of a dilute superconducting alloy (i.e., subject to the condition $\omega_D\tau \gg 1$) in the presence of strong magnetic field and above the transition temperature. Then, the free energy and the magnetization were calculated microscopically. The procedure used in an earlier work on pure superconductors is justified, but important additional contributions are found for alloys. (auth)

10226 MAGNETIC SUSCEPTIBILITY AND TRANSITION TEMPERATURE IN THE SUPERCONDUCTING STATE OF Nb–Sn ALLOY. Korsunskii, M. I.; Baranov, I. A.; Genkin, Ya. E.; (and others). Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 75-7(Mar-Apr 1971). (In Russian).

The magnetic susceptibility of Nb–Sn alloys was measured at the following weight percentages of Sn: 7.5, 10.8, 11.5, 12.3, 22.7, 27.2, 33.6, 37.2, 65, 78.5, 85, and 91.8, and was found to decrease with increasing Sn content. Between 22.7 and 65% Sn, the susceptibility is only weakly affected by the Sn content. The transition temperature in the superconducting state was determined for all of the compositions listed. (tr-auth)

10227 TEMPERATURE DEPENDENCE OF STRUCTURE ON THE I–V CURVES OF SUPERCONDUCTING POINT CONTACTS. Puma, Marcello; Deaver, Bascom S. Jr. (Univ. of Virginia, Charlottesville). Appl. Phys. Lett.; 19: No. 12, 539-41(15 Dec 1971).

In addition to the structure at $V = 2\Delta/ne$ (2Δ is the energy gap, n is an integer), prominent structure is observed on the I–V curves of superconducting point contacts at $V \gg 2\Delta/e$. The temperature dependence of all the structure was studied and some features were found to vary like $\Delta(T)$ and others linearly with T^4. These variations are interpreted in terms of a simple equivalent circuit model of the point contact and indicate that all of the features for clean point contacts are related to the Josephson effect. (auth)

10228 THERMAL HALL EFFECT IN SUPERCONDUCTORS. Sichel, Enid Keil. New Brunswick, N. J.; Rutgers-The State Univ. (1971). 104p. University Microfilms Order No. 72-876.

Thesis.

A transverse temperature gradient odd in magnetic field in the presence of a longitudinal temperature gradient was observed in thin strips of Pb + 5, 7.5, and 11 at. % In and In + 5, 9, and 11 at. % Pb with the plane perpendicular to the field. The tangent of the Righi–Leduc angle, tan θ, is defined as the ratio of the transverse to the longitudinal temperature gradients. Tan θ was studied as a function of magnetic field in the normal and mixed state of these type-II superconductors. In the normal state of both sets of alloys, tan θ was found to be negative and linear in H. Tan θ could be extrapolated to the origin. Below H_{c2} in the mixed state of the Pb–In alloys, tan θ rose to a peak of the same sign as the normal state data. In the mixed state of the In–Pb alloys, tan θ reversed sign and showed a peak of opposite sign below H_{c2}. In the normal state of both sets of alloys, tan θ scaled inversely with residual resistivity. Thus tan θ is a measure of $\omega_c\tau$, where ω_c is the cyclotron frequency and τ the electron scattering time. In the mixed state of the Pb–In alloys, tan θ scaled inversely with residual resistivity. The In–Pb alloys did not scale well in the mixed state. While several of the other thermomagnetic effects, such as the Hall effect, have been observed in type-II superconductors, they all require the fluxoid lattice to be in motion. From measurements of the Nernst effect and the critical current density in some of the alloys of experiments reported here, it was concluded that the fluxoid lattice was not moving. The results differ from measurements by Weijsenfeld of the Hall effect in similar alloys. The results are similar in the normal state, but in the mixed state the Hall angle rises steeply below H_{c2}; in In–Pb alloys it reverses sign below H_{c2}. Thus the sign of the Hall angle in the mixed state is exactly opposite to the sign of the Righi–Leduc angle. It is suggested that these effects in the mixed state may be explained by the coupling in the vortex cores between the lattice vibrations and the electron gas via phonon drag. (TSS) (Diss. Abstr. Int., B)

10229 RF-INDUCED EFFECTS IN JOSEPHSON TUNNEL JUNCTIONS. Hamilton, Clark Allen. Rochester, N. Y.; Univ. of Rochester (1971). 111p. University Microfilms Order No. 72-720.

Thesis.

An experimental investigation of the effects of microwave radiation on tin/oxide/tin superconducting tunnel junctions is reported. Effects related to both the Josephson current and the quasi-particle current are studied. A standing-wave model is proposed in order to resolve experimental discrepancies with the theory of the quasi-particle effects. This model is justified on a physical basis and is shown to be a realistic picture of the rf field in a relatively large thin-film tunnel junction. When included as a modification of the theory, the model gives qualitative agreement with data on both the Josephson effects and the quasi-particle effects. Of greater significance, these results demonstrate that in order for a junction to show ideal high-frequency behavior, it must be small enough to avoid a spatial variation of

the rf field. This conclusion is further verified in experiments with junctions that are very small and thus have a uniform rf field distribution. The results of these experiments are in excellent agreement with the unmodified theory for both the Josephson effects and the quasi-particle effects. The low frequency equivalence of the quasi-particle effects and classical rf detection is also pointed out and used to demonstrate that the magnitude of the rf voltage appears correctly in the theory. Using frequencies in the range 20 to 26 GHz and very small junctions, the Josephson step amplitudes were measured out to a value of $2\alpha = 2eV_{rf}/hf \simeq 100$. At values of $2\alpha > 25$, significant deviations from the usual Bessel function behavior ($|J_N(2\alpha)|$) begin to occur. These deviations are correctly predicted in the microscopic theory of Werthamer and are a consequence of the logarithmic singularity in the ac Josephson current at a Josephson frequency $f_J = 4\Delta/h$, i.e., the Riedel peak. Careful quantitative measurements of this behavior demonstrate the existence of the peak and determine its shape in the region near $f_J = 4\Delta/h$. (Diss. Abstr. Int., B)

10230 AC MEISSNER-STATE ENERGY LOSS. Skinner, Roger Hal. Salt Lake City; Univ. of Utah (1971). 120p. University Microfilms Order No. 72-2129.

Thesis.

Energy loss of a nonhysteretic origin was measured in Type-I superconducting lead in the complete Meissner state over a range of less than 0.5°K below the transition into the intermediate state. Measurements extended from the transition at 7°K (corresponding to an applied field of 20 gauss) down to the transition at 3.6°K (corresponding to an applied magnetic field of 400 gauss). The spherical single-crystal sample was 99.9999% pure lead with a resistivity ratio (ρ_{295}/ρ_4) greater than 10^4. The superconducting lead sphere was suspended by a quartz fiber forming a torsion pendulum. By measuring the Q, loss as small as 10^{-16} watts per cm^2 of the sample surface area at one Hz could be detected. This compares with 10^{-13} watts per cm^2 as reported in the literature for similar techniques. The measured loss is not caused by trapped flux in the sample and is consistent with the Meissner effect. The ac loss is a function of the normal-state resistivity, the externally applied magnetic field, the superconducting penetration depth, and the temperature difference between the point of measurement and the transition into the intermediate state. The loss is found to be amplitude-independent and to have a frequency dependence similar to that of Joule-heating losses. (Diss. Abstr. Int., B)

10231 ELASTIC SOFTENING AND SUPERCONDUCTIVITY IN V_3Si. Dieterich, W. (Institut Max von Laue-Paul Langevin, Garching, Ger.). Phys. Lett.; 37A: No. 5, 409-10(20 Dec 1971).

A density of states as it is used in the Labbé-Friedel model of A15 compounds can explain the experimentally observed arrest of the elastic softening of V_3Si at the superconducting transition T_c. (auth)

10232 OSCILLATORY SOLUTIONS OF GENERALIZED GINZBURG-LANDAU EQUATIONS AT H_{c1}? Krey, U. (Univ., Hamburg). Phys. Lett.; 37A: No. 5, 421-2(20 Dec 1971).

The Ginzburg-Landau equations are generalized beyond Tewordt's equations, taking into account higher derivatives of the order parameter. It is shown that the oscillatory flux line profiles recently obtained by Hubert with Tewordt's equations are unphysical. (auth)

10233 SUPERCONDUCTING SURFACE RESISTANCE OF AMORPHOUS AND CRYSTALLINE $Pb_{55}Bi_{45}$. Buckel, W.; Hasse, J.; Reichert, V. (Univ., Karlsruhe, Ger.). Phys. Lett.; 37A: No. 5, 457-8(20 Dec 1971).

Measurements of microwave surface resistance can give information about electronic parameters in the amorphous and the crystalline state. The temperature dependence shows deviations from the BCS function. Residual absorption in the superconducting state is less than 10^{-3} of the normal state. (auth)

10234 MAGNETIC PROPERTIES OF SUPERCONDUCTING VANADIUM. Sekula, S. T.; Kernohan, R. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 5: No. 3, 904-11(1 Feb 1972).

Isothermal magnetization data were obtained for an annealed single crystal of vanadium (resistivity ratio $\rho_{273K}/\rho_{4K} = 450$) in prolate spheroidal form in the temperature interval from T = 1.4 K to T_c (=5.43 K), which was measured to be 5.43 ± 0.02 K. To minimize surface pinning and increase the reversibility of the bulk magnetization, the sample surface was subjected to an oxidation treatment. Values of the thermodynamic critical field $H_c(t)$ determined from the data are in good accord with the earlier results of Radebaugh and Keesom, and the Ginzburg-Landau parameter was deduced from the measurements to be $\kappa(1) = 0.85 \pm 0.02$. In the limit of infinite electronic mean free path it is found that $\kappa_0 = 0.82$ for this sample. The temperature variations of $\kappa_1(t)$, $\kappa_2(t)$, and the parameter $h^*(t) = H_{c2}(t)/(-dH_{c2}\ dt)_{t=1}$ are discussed and compared with previous work. The results tend to confirm the importance of Fermi-surface anisotropy effects in type-II superconductors in the clean limit. (auth)

10235 OCCURRENCE OF SUPERCONDUCTIVITY IN SIMPLE-CUBIC $(Au_{1-x}Pd_x)Te_2$ ALLOYS. Chen, Wilkie Y. K.; Tsuei, C. C. (California Inst. of Tech., Pasadena). Phys. Rev., B; 5: No. 3, 901-3(1 Feb 1972).

The superconducting transition temperatures and lattice parameters of metastable simple-cubic alloys $(Au_{1-x}Pd_x)Te_2$, with $0 \leq x \leq 0.6$, obtained by rapid quenching from liquid state, were measured as a function of x. As x increases, the transition temperature T_c goes through a minimum of 1.6°K near x = 0.05, then increases steadily to a maximum of 4.5°K at x = 0.45. The lattice parameter shows a slight linear decrease as x increases. The transverse magnetoresistance for the composition x = 0.2 saturates at a relatively low field (~2 kG) and is unusually large (~0.14). The initial depression of T_c with increasing Pd content can be interpreted in terms of the information obtained in a previous study of binary Au-Te alloys. The unusual increase of T_c with further increase in the Pd concentration is not well understood. (auth)

10236 SUPERCONDUCTIVITY AND MAGNETORESISTANCE IN $NbSe_2$. Morris, R. C. (Univ. of Virginia, Charlottesville); Coleman, R. V.; Bhandari, Rajendra. Phys. Rev., B; 5: No. 3, 895-901(1 Feb 1972).

Electron conduction in single crystals of $NbSe_2$ was measured at 4.2°K in magnetic fields up to 150 kOe. The upper critical field H_{c2} was measured as a function of the angle between the applied field and the layers of the crystal for currents flowing both parallel and perpendicular to the layers. An effective-mass model based on simple considerations of the anisotropy of the crystal was used to obtain a value for the ratio of effective masses for electron motion parallel and perpendicular to the layers, and the best value obtained is $m_\parallel/m_\perp = 0.09 \pm 0.01$. Transverse-magnetoresistance rotation diagrams were studied, and structure due to flux flow and flux pinning was observed. (auth)

10237 SPIN-ORBIT EFFECTS IN ALLOYS IN POROUS GLASS WITH H_{c2} ABOVE 200 kG. Watson, J. H. P. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., B; 5: No. 3, 879-83(1 Feb 1972).

The critical field H_{c2} was measured for a Pb-40 at. %-Bi alloy in porous-glass samples with pore diameters in the range 20 to 60 Å. Werthamer et al. have calculated H_{c2}, including the effect of electron paramagnetism and spin-orbit scattering. This theory fits the data for the 32- and 60-Å samples, giving the spin-flip scattering length of the order of the grain diameter. For the 20-Å samples the theory does not fit the results. It is suggested that the behavior of this sample is largely "one-dimensional." (auth)

10238 FLUCTUATION EFFECTS ON THE SUPERCONDUCTING TRANSITION OF TIN WHISKER CRYSTALS. Newbower, R. S.; Beasley, M. R.; Tinkham, M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., B; 5: No. 3, 864-8(1 Feb 1972).

The results of measurements of the resistive transitions of clean one-dimensional superconductors (pure tin whiskers) at currents of ~10^{-7} A are reported. Comparison with the McCumber-Halperin theory, including consideration of the current-dependent terms necessary at these current levels, yields good agreement with no adjustment of the attempt frequency. It is conjectured, however, that precise conclusions concerning the magnitude of the attempt frequency cannot yet be drawn. Rather, arguments are presented which suggest that a meaningful fit to the data in the top portion of the transition must await an improved theory, and that adjustments of the attempt frequency such as those used by Lukens, Warburton, and Webb (in fitting lower-current data) may not be meaningful. (auth)

10239 THERMODYNAMICS OF THE PROXIMITY EFFECT: SPECIFIC-HEAT JUMPS IN LAMELLAR LEAD-TIN EUTETIC ALLOYS. Lechevet, Jon; Neighbor, J. E.; Shiffman, C. A. (Northeastern Univ., Boston). Phys. Rev., B; 5: No. 3, 861-4 (1 Feb 1972).

The specific-heat jump at the critical temperature was determined as a function of D_S, the thickness of the superconducting layers. For thick layers, the jump decreases rapidly as D_S decreases, approaching a limit of about one-half the bulk value. A second jump in the specific heat (associated with the transition in the "normal" layers) decreases rapidly as the normal-layer thickness decreases, and extrapolates to zero for $D_N \approx 1/4\ \mu$. (auth)

10240 ELECTRONIC THERMAL CONDUCTIVITY OF SUPERCONDUCTING THIN FILMS OF INDIUM-MANGANESE ALLOYS.

Bjerkaas, Allan W.; Ginsberg, D. M.; Mrstik, B. J. (Univ. of Illinois, Urbana). Phys. Rev., B; 5: No. 3, 854-61(1 Feb 1972).

The transition temperature T_c and the thermal conductivity of thin films of superconducting indium and indium–manganese alloys were measured at temperatures from 1.2 to 4.2 K. The films contained 0.0 to 0.0567 at. % manganese. They were quench condensed on thin substrates at 4 K, and were kept below 5 K throughout the measurements. The dependence of T_c on manganese concentration is in excellent accord with the theory of Abrikosov and Gor'kov. However, the thermal-conductivity data are in systematic disagreement with the theory of Ambegaokar and Griffin and of Bennemann. This observation is related to discrepancies with theory which have been seen in the results of other experiments on the effect of transition-element magnetic impurities. Some approximations in the theory are listed which may account for the difficulty. (auth)

10241 THERMAL CONDUCTIVITY OF NIOBIUM IN MAGNETIC FIELDS NEAR H_{c2}. Moore, B. K.; Satterthwaite, C. B. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 28: No. 1, 28-30 (3 Jan 1972).

Thermal-conductivity measurements are reported on two samples of pure Nb in magnetic fields near H_{c2}. The measurements are in excellent agreement with the dependence on field, electron mean free path, and field orientation predicted by the recent theory of Houghton and Maki. The magnitude of the depression of the thermal conductivity in the mixed state is, however, about a factor of 2 less than predicted. (auth)

Equipment and Devices

Refer also to abstracts 10675, 10691, and 10692.

10242 (KFK–1347) MEASUREMENT OF THE THERMAL CONDUCTIVITY OF SUPERCONDUCTING COIL WINDINGS BETWEEN 4 AND 10°K. Krafft, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jun 1971. 24p. (In German). Dep. NTIS (U. S. Sales Only).

Thermal conductivity measurements of different superconducting coil windings and epoxy resins between 4 and 10K are described. By admixture of Al_2O_3 or Cu powder, the thermal conductivity of epoxy resin could be improved by a factor of five from 3.5×10^{-4} to 1.5×10^{-3} W/cm · K. With regard to coils fabricated of wires with pure Cu matrix, coils made of superconducting multicore wire with a CuNi matrix potted with epoxy resin had the worst conductivity ($\sim 9 \times 10^{-4}$ W/cm · K) at 4.2K. (auth)

10243 THERMAL SEPARATION OF TWO TUBES, ONE POSITIONED WITHIN THE OTHER. (to Siemens Aktiengesellschaft). British Patent 1,256,475. 8 Dec 1971. Priority date 25 Jul 1969, Germany.

A device is described for maintaining a desired spacing between a first tube and a second tube extending within the first tube. The device comprises a frame structure for surrounding the second tube within the first tube. The frame structure has poor thermal conductivity and is provided with three inwardly projecting parts arranged for making small-area contact with the outside of the second tube, at respective positions spaced at substantially 120° intervals around its axis, so as to maintain the frame structure in a predetermined spaced relationship with the second tube. The structure is also provided with three outwardly projecting parts arranged for making small-area contact with inside of the first tube, at respective locations which are substantially in the middles of the said 120° intervals, so as to maintain it in a predetermined spaced relationship with the frame structure. One claim is a superconductor electric cable where the superconducting material is located within the second tube. (M.H.R.)

10244 ^{3}He CRYOSTAT FOR NUCLEAR ORIENTATION BY ADIABATIC DEMAGNETIZATION WITH A SUPERCONDUCTING SOLENOID. Iwata, Shiro; Yoshida, Hiroyuki; Kodaka, Hisao; (and others). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 90-3(1971).

For low temperatures below 0.1°K for experiments on fission of oriented nuclei, a ^{3}He refrigerator with an adiabatic demagnetization system was designed. The gas circulation loops are also described, and the intensity distribution of the magnetic field is shown. Difficulties in temperature measurement are discussed. (D.L.C.)

10245 SELF-PUMPED JOSEPHSON PARAMETRIC AMPLIFICATION. Kanter, H.; Silver, A. H. (Aerospace Corp., Los Angeles). Appl. Phys. Lett.; 19: No. 12, 515-17(15 Dec 1971).

Parametric gain has been demonstrated at 30 MHz using the nonlinear inductance of Josephson point-contact devices. SQUID-type configurations were used to achieve degenerate-mode negative-resistance amplification with self-pumping achieved via the internal Josephson oscillations. Gain as large as 11 dB was measured. The small-signal analysis predicts parametric amplification and delineates the importance of the critical current, circuit loss, and circuit coupling efficiency. (auth)

Radiation Physics and Shielding

Refer also to abstract 10901.

Radiation Physics

Refer also to abstracts 10303 and 10780.

10246 (UCID–30023) USER'S MANUAL FOR THE BUCKLE X-RAY DEPOSITION PROGRAM. Edwards, Arthur L. (California Univ., Livermore. Lawrence Radiation Lab.). 1 Sep 1971. Contract W-7405-eng-48. 27p. Dep. NTIS.

The BUCKL code has been adapted to run on the LLL CDC/6600 monitor system. This version is called BUCKLE. BUCKLE provides a means for fast calculation (several seconds per problem) of the deposition of x rays with energies in the 0.1 to 1000 keV range in cool (nonionized) materials. The calculation includes the effects of photoelectric absorption, Compton absorption and scattering, fluorescence, scattering losses due to the finite diameter transverse to the incident beam, voids between materials, and losses at the front and back surfaces. Its agreement with more accurate codes, such as TORTE, that require much more computer time is generally within 5 to 10%; and it is far more accurate than exponential codes, such as PURPLE, that only calculate absorption. A number of changes were made in the input and output data, in the method of calculating photoelectric cross sections, and in the methods of calculating currents and exit-spectrum intensities to simplify the use of the code, to make the calculations more accurate, and to provide all the necessary data for interpreting the results. The input and output data are described for users of the BUCKLE code. (auth)

10247 COMPARISON OF THE EXTRAPOLATED RANGES OF ACCELERATED ELECTRONS IN WATER AND POLYSTYRENE. Garsou, J. (Univ., Liege). J. Radiol., Electrol., Med. Nucl.; 52: No. 10, 606-7(Oct 1971). (In French).

Polystyrene can replace the water used in photographic dosimetry along the axis of a 10- to 34-MeV electron beam from a betatron; in this way the extrapolated ranges of the electrons may be determined. (France)

10248 INDUCED BREMSSTRAHLUNG EFFECT IN NONMONOCHROMATIC RADIATION FIELD. Bunkin, F. V.; Karapetyan, R. V. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 950-5(1971). (In Russian).

The induced bremsstrahlung effect in the nonmonochromatic radiation field is considered in the first Born approximation over the scattering (Coulomb) potential. The asymptotic behavior in weak and strong fields is established for the value χ, which characterizes the mean change of the electron energy at one event of scattering. The applicability condition of the perturbation theory over the radiation field is represented in a form that does not specify the form of the spectrum. (auth)

10249 ENERGY DEPOSITION AND PENETRATION DEPTH OF HEAVY IONS IN ELECTRONIC STOPPING REGION. Sigmund, P.; Matthies, M. T.; Phillips, D. L. (Argonne National Lab., Ill.). Radiat. Eff.; 11: No. 1, 39-49(Oct 1971).

Previous calculations of spatial moments over the distribution of ion ranges and bombardment damage were extended into the range of ion energies where electronic stopping is important. Numerical solutions are given of well-known integral equations, under the assumption of Thomas–Fermi scattering and velocity-proportional electronic stopping, for equal masses of ion and target and five values of the electronic stopping constant, over a range of four decades of ion energy. The results are compared with experimental damage distributions, with good success. Implications on sputtering are mentioned briefly. (auth)

10250 CALCULATION OF A GAMMA-RADIATION FIELD BY THE MONTE CARLO METHOD FOR STATISTICALLY INHOMOGENEOUS MEDIA. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 65-8(1971). (In Russian).

The problem of a computed gamma-radiation field is examined for a medium with random inhomogeneities. An algorithm solution is obtained for this problem by the Monte Carlo method with the aid of perturbation theory. (tr-auth)

10251 TEMPERATURE DEPENDENCE OF THE THERMAL FACTOR OF X-RAY SCATTERING. Korsunskii, M. I.; Genkin, Ya. E.; Vigdorchik, L. I.; Kuz'minov, A. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 65-7(Mar-Apr 1971). (In Russian).

A method of measuring the thermal factors of x-ray scattering is described which uses the "ordinate-fragment" method on the experimental lines determined at different temperatures. There is no necessity to treat the background lines. (tr-auth)

10252 METHOD FOR EXPERIMENT ON SCATTERING AND DIFFRACTION OF RESONANT GAMMA QUANTA. Zasimov, V. S.; Kuz'min, R. N.; Firov, A. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 3, 324-8(May-Jun 1971). (In Russian).

Equipment for conducting experiments on scattering and diffraction of resonant gamma radiation is described. The maximum signal-to-background ratio was achieved with the aid of rigorous collimation of the incident and scattered beams of gamma quanta. In experiments it is advantageous to use a scintillation detector. Diffraction spectra were obtained from samples with and without resonant nuclei. (tr-auth)

10253 SLOW NEUTRON SCATTERING AND CLASSICAL MEAN-SQUARE DISPLACEMENT FUNCTIONS OF ATOMS. Nishigori, Takeo; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 406-7(Jul 1971).

An attempt is made to find a well-defined relationship between the classical mean-square displacement function of atoms and the scattering cross section of slow neutrons. The general quasi-classical method used here takes the recoil effect directly into account by replacing the commutators by the corresponding classical Poisson brackets. (M.H.R.)

10254 BRACKETING THE PEAK PRIMARY GAMMA-RAY DOSE RATE FROM NUCLEAR DEVICES BY STEADY-STATE TRANSPORT CALCULATIONS. Claiborne, H. C.; Engle, W. W. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 13: No. 2, 209-15(Feb 1972).

Electronic components can be affected by the dose rate from gamma rays delivered during the first few shakes (10^{-8} sec/shake) of an exploding nuclear device. Determining such dose rates generally require expensive time-dependent calculations. It is demonstrated that relatively inexpensive steady-state transport calculations can be used to bracket time-dependent peak dose rates with meaningful upper and lower limits. The model configuration consisted of a sphere of air surrounded by a spherical annulus of concrete with an isotropic source of gamma rays from fissioning ^{235}U located at the geometric center. Steady-state calculations were made with the discrete ordinates code ANISN and the time-dependent calculations with TDA (time-dependent ANISN). The upper-limit dose rates were obtained by dividing the steady-state total dose by the pulse width of the device. This is equivalent to assuming that the uncollided and air-scattered fluxes arrive at the shield simultaneously. For a lower-limit calculation, only the uncollided flux was considered incident on the shield. Calculations were made for a 120-cm-thick concrete shield for ranges of 500, 1000, and 5000 meters and for step-function burst pulse widths of 1 through 8 shakes. The results from the steady-state calculations generally bracketed the peak time-dependent dose rates within an acceptably narrow band except for the 500-meter range at the back end of the shield where the peak time-dependent dose rates were highest for all pulse widths. This apparent anomaly is explained on the basis of using a moving boundary condition in the time-dependent solution and the effect is shown to be of no consequence. (auth)

10255 IMPLICIT MONTE CARLO SCHEME FOR CALCULATING TIME- AND FREQUENCY-DEPENDENT NONLINEAR RADIATION TRANSPORT. Fleck, J. A. Jr.; Cummings, J. D. (Univ. of California, Livermore). J. Comput. Phys.; 8: No. 3, 313-42(Dec 1971).

A flexible and accurate method for solving nonlinear, frequency-dependent radiative transfer problems by a Monte Carlo technique is developed. The method is based upon the concept of effective scattering, wherein a fraction of the radiative energy absorbed is instantaneously and isotropically reradiated in a manner analogous to a scattering process. The method appears to be unconditionally stable, conserves energy exactly, and is suitable for handling either transparent or optically thick media. (auth)

Shielding

10256 (AAEC/E-222) ANISOTROPIC COLLISION PROBABILITIES FOR ONE DIMENSIONAL GEOMETRIES. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1971. 27p. Dep. NTIS (U. S. Sales Only).

The equations for P_0 and P_1 collision probabilities in slab, spherical and cylindrical geometries are presented. A method of solution of the resulting multigroup neutron flux equation is discussed. The extension of S_n codes to incorporate anisotropic scattering is straightforward and the time penalty incurred in the calculation of the P_1 flux and source is small. The corresponding extension of the collision probability method is difficult, and doubling the length of the flux vector increases the solution time dramatically. It is, therefore, concluded that the S_n method will be superior for most anisotropic calculations. (auth) (Australia)

10257 (RD/B/N-2073) PROPAGATION OF GAMMA RADIATION ALONG A LABYRINTH: EXPERIMENTAL RESULTS. Fraser, A. J.; Gayton, F. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sep 1971. 25p. (RPC/Sh/P-(71)8). Dep. NTIS (U. S. Sales Only).

Measurements were made, using a sodium iodide detector, of the γ-flux spectrum along a labyrinth when a ^{226}Ra source (E_{max} = 2.43 MeV) was exposed in a shielded cell connected to the labyrinth. All walls of the cell and labyrinth were concrete. Results are intended to contribute towards data for checking computer codes for γ-ray streaming in ducts. (UK)

10258 BUILDUP FACTORS FOR RECTANGULAR SLAB SHIELDS. I. MULTIPLE SCATTERING MODEL FOR GAMMA RAYS AND APPLICATION TO RECTANGULAR SLAB SHIELDS. Yamakoshi, Hisao (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo Hokoku; 8: No. 2, 33-56(Mar 1971). (In Japanese).

Since the behavior of the energy buildup factor for a finite slab shield has not been clarified, both experimental and theoretical studies were performed to estimate the influence of finiteness on the energy buildup factor. Results of the studies are summarized in an expression for the correction factor to be multiplied by the energy buildup factor for infinite slabs to yield an energy buildup factor for finite ones. The amount of the correction depends on the energy and direction of the incident gamma-ray beam as well as the geometry of the slab and position of detector relative to the slab. As an example of application of the obtained expression in actual problems, prediction of the energy buildup factor is performed for some given sets of values of relevant quantities. Results of prediction are compared with experimental results to estimate the accuracy of the prediction. The theoretical study is based on a simple physical model for the mechanism of the contribution of multiple scattering on the energy spectrum of transmitted gamma rays. The model is devised, from the viewpoint of the successive scattering method, so that the expression for the energy spectrum is simple enough to allow a hand calculation without sacrificing accuracy. The validity of the model is verified by comparing both the calculated energy spectrum and the calculated angular distribution of transmitted energy with experimental results or Monte Carlo results in the case of incident gamma rays collimated as a narrow beam. (auth) (Japan)

Solid-State Physics

Refer also to abstract 10724.

Radiation Effects

Refer also to abstracts 9399, 9447, 10033–10043, 10249, and 10696.

10259 (BNL-50310, pp 179-82) ION SOURCE REQUIREMENTS FOR ION IMPLANTATION. Wilson, R. G. (Hughes Research Labs., Malibu, Calif.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Of the parameters that describe aspects of ion sources, those of greatest concern for application to ion implantation are versatility of ion species produced, ease and quickness of change among ion species, ion current produced (of the desired species), reliability, lifetime, and ease of maintenance. An ion source defined here includes all of the equipment necessary to introduce ions of the desired species into the next element of an implantation system (an accelerator). The components dealt with are the ionization chamber, the feed system for the material to be ionized, the ion extraction region, and all associated electronics. One feature of an ion source for implantation which is discussed at length is that of providing a versatile source of the required current of ions of interest for implantation doping of semiconductor materials. The discussion elaborates the materials that have been found to be effective sources of the ions of interest, the composition of the mass

spectra, and the current of the elemental ion produced, all from the one ion source described. (W.H.K.)

10260 (BNL–50310, pp 191-7) BEAM-PLASMA TYPE ION SOURCE FOR HIGH CURRENT OPERATION. Takagi, T.; Yamada, I.; Ishikawa, J. (Kyoto Univ. (Japan)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

To obtain an intense and fine ion beam for ion implantation in semiconductors, a new ion source is studied. By forcing a magnetically focused electron beam through a neutral gas in a drift tube, a plasma is generated. This plasma acquires a density orders of magnitude higher than that expected from the primary ionization alone, since the beam–plasma interaction causes the beam–plasma discharge when the gas pressure exceeds a certain critical value. This new-type ion source, which generates and focuses the plasma simultaneously by an electron beam, may be called the beam–plasma type ion source. A normalized emittance of 3.8×10^{-8} rad · m and a normalized brightness of 1.48×10^{11} A · rad^{-2} · m^{-2} have been obtained with a 1-mA ion beam. The lifetime of this ion source is expected to be long because the cathode is used in a high vacuum without ion bombardment. (auth)

10261 X-RAY EXCITATIONS OF IONIC CRYSTALS AND THEIR ROLE IN RADIATION DEFECT CREATION PROCESSES. Elango, M. A. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR; No. 38, 28-49(1970). (In Russian).

The role of x-ray excitations in radiation-defect creation processes in ionic crystals is discussed. Attention is paid to the threshold energies for the generation of multicharged ions in crystals. An experimental investigation of the energy-level diagrams of filled electron levels of NaCl, KCl, KBr, and KI (by measurements of kinetic energies of x-ray photoelectrons) and analysis of relaxation processes after ionization of inner electron shells were carried out. The structure of the absorption spectra of NaCl in the x-ray region is discussed. It is shown that the most promising objects for the investigation of the role of the Varley mechanism in the creation of radiation defects are bromides and iodides of alkali metals (in which threshold energies for the generation of twofold ionized anions must be close to 31–32 eV and 51–52 eV). (auth)

10262 INVESTIGATION OF ELECTRON AND HOLE PROCESSES IN IONIC CRYSTALS BY METHODS OF MEASURING NONISOTHERMIC RELAXATION OF ESR AND LUMINESCENCE. Pung, L. A.; Khaldre, Yu. Yu. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR; No. 38, 50-84(1970). (In Russian).

The variations in the number of hole and electron color centers in KCl : Ag, NaCl : Ag, NaCl : Cu, and NaCl : CuAg single crystals x-irradiated at 77°K were investigated by the ESR method in their dependence on the temperature of pulse annealing. The intensity of the ESR absorption served as a measure of the number of color centers. The ESR data permit a reliable determination of the "polarity" (electron or hole character) of the observed stages of the relaxation processes. It was found that some relaxation processes at temperatures lower than room temperature are hole processes and the luminescence is a tunneling process. (auth)

10263 IONIZATION OF LUMINESCENCE CENTERS IN THALLIUM- AND INDIUM-DOPED KCl CRYSTALS BY MEANS OF ELECTRON EJECTION OR HOLE TRAPPING. Lukantsever, N. L. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR; No. 38, 85-102(1970). (In Russian).

By means of the absorption method, hole trapping by Tl^+ and In^+ ions was investigated in KCl : Tl; KCl : Tl, Ag; and KCl : In, Ag. The crystals were excited by x rays at liquid nitrogen temperature or ultraviolet radiation at room temperature. Absorption bands of Tl^{2+} and In^{2+} appear after the thermal destruction of V_k centers in x-irradiated crystals. The absorption bands of In^{2+} arise after the excitation of KCl : In, Ag by ultraviolet light absorbed in C bands of In^+ centers (electron transitions $^1S_0 - {}^1P_1$). A variant of the interpretation of Tl^{2+} and In^{2+} absorption spectra is suggested. In^+ emission appears during the recombination of electrons with In^{2+} centers (electron recombination luminescence) and during the recombination of holes with In^0 centers (hole recombination luminescence). (auth)

10264 PHOTOLUMINESCENCE IN γ-IRRADIATED VITREOUS AND MONOCRYSTALLINE As_2S_3 AND As_2Se_3. Kolomiets, B. T.; Mamontova, T. N.; Domoryad, I. A.; Babaev, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Status Solidi (a); 7: No. 1, K29-32(16 Sep 1971).

Photoluminescence in single crystals and glasses of As_2S_3 and As_2Se_3 following ^{60}Co gamma irradiations of 10^6 to 10^9R was studied in the 0.6- to 1.6-eV range. The shapes of the recombination radiation spectra are unchanged, with small-peak shifts toward lower and higher energies for As_2S_3 and As_2Se_3, respectively. The effects of irradiation on maxima, half-widths, and intensities are tabulated. (D.L.C.)

10265 DOPING DEPENDENCE OF THE INTERNAL QUANTUM EFFICIENCY OF SPONTANEOUS ELECTRON–HOLE RECOMBINATION IN n-TYPE SAMPLES OF GaAs EXCITED BY A 30-kV ELECTRON BEAM AT 300°K. Biswas, S. N.; Rakshit, S.; Chakravarti, A. N. (University Coll. of Tech., Calcutta). Phys. Status Solidi (a); 7: No. 1, 233-8(16 Sep 1971).

The doping dependence of the internal quantum efficiency in n-type samples of GaAs excited by a 30-kV electron beam at 300°K is theoretically studied, taking into account the effect of electron–hole recombination through the surface states. It is found that the internal quantum efficiency remains independent of the extent of doping for donor concentrations less than 4×10^{17} cm^{-3}, shows a maximum at the doping density of 7.2×10^{17} cm^{-3}, and then decreases sharply. The nature of this dependence is found to be somewhat similar to that of the bulk quantum efficiency (which excludes the recombination at the surface and in the bulk material in the immediate vicinity of the surface) as studied elsewhere. It is, therefore, concluded that the effect of surface recombination on the quantum efficiency of spontaneous recombination is not very much dependent on the donor concentration, at least for higher energies of the electron beam. (auth)

10266 PROPERTIES OF SELF-ION IRRADIATED THIN FILMS. Krimmel, E. F. (Siemens AG, Munich). Phys. Status Solidi (a); 7: No. 1, 141-50(16 Sep 1971).

Thin films vacuum deposited under simultaneous self-ion irradiation show strong crosslinking with the substrate, bulk-like properties with enhanced oriented structure, caused by internal electric microfields during island formation, and a constant concentration of radiation damage mainly of the vacancy type. With a continuous annealing procedure, annealing substages III in Au-ion irradiated Au films not previously observed by other radiation damage experiments are detected. The activation energies of the processes are determined from the film thickness-dependent temperature shift of the annealing stages. (auth)

10267 RADIATION DEFECTS IN FAST-NEUTRON IRRADIATED HIGH-PURITY SILICON. Semenyuk, A. K.; Khivrich, V. I.; Konozenko, I. D. (Inst. of Nuclear Research, Kiev). Phys. Status Solidi (a); 7: No. 1, 51-9(16 Sep 1971).

Radiation defects created by fast pile neutrons in high-purity n-type Si($\rho = 2 \times 10^3$ to 5×10^3 Ωcm) and p-type Si($\rho = 1.6 \times 10^4$ to 4×10^4 Ωcm) were investigated, using Hall-effect and minority-carrier-lifetime measurements. The oxygen concentrations in the crystals were in the range of 5×10^{14} to 5×10^{15} cm^{-3}. It is shown that disordered regions are introduced and a level at (E_v + 0.35) eV is observed. The Fermi level in both n- and p-type Si shifts to the middle of the gap. The introduced defects are effective recombination centers with a level at (E_v + 0.35) eV and electron cross section $\sigma_n = 5 \times 10^{-14}$ cm^2. Concerning the stability to annealing there are two types of disordered regions, the first of which is slightly stable and destroyed in the temperature range 20 to 250°C, and the second one is destroyed only between 600 and 700°C. The carrier-removal rate for the defects of the first type is 0.3 neutrons^{-1} cm^{-1} and for the defects of the second type is considerably less (about 4×10^{-2} neutrons^{-1} cm^{-1}). After the destruction of the disordered regions, divacancies appear. It is supposed that the disordered regions of the first type are rich in divacancies and still crystalline, and the second ones have some part of amorphous structure. The defects of the first type are probably formed as a result of the sliding collisions of neutrons with the nuclei or under the action of the fission neutron. The disordered regions of the second type are probably formed by frontal collisions of high-energy neutrons with the silicon nuclei. (auth)

10268 ION BOMBARDMENT OF HCP AND FCC COBALT IN THE ELECTRON MICROSCOPE. Howe, L. M.; Rainville, M. (Chalk River Nuclear Labs., Ont.). Phys. Status Solidi (a); 7: No. 1, 125-34(16 Sep 1971).

Visible defects having diameters ranging from 15 to 80 Å were produced in hcp and fcc cobalt during bombardment at about 20°K with 100-keV O^- ions in the electron microscope. The principal component of the strain field was along ⟨111⟩ for the majority of the defects in the fcc regions and along ⟨20$\bar{2}$3⟩ for many of the defects in the hcp regions. The strain fields are consistent with that expected for dislocation loops lying on {111} planes and having $\frac{1}{3}$ ⟨111⟩ Burgers vectors in the fcc case and dislocation loops lying on the (0001) plane and having $\frac{1}{6}$ ⟨20$\bar{2}$3⟩ Burgers vectors in the hcp case. It is not possible, however, to differentiate between a single dislocation loop and an assembly of small narrowly spaced loops all having the same Burgers vector and the same loop habit

plane. Stereo analysis of the defects produced during ion bombardment at about 20°K was performed at 300°K. The analysis showed that vacancy-like defects were involved. It is proposed that the defects represent depleted regions formed directly in the collision cascade. (auth)

10269 ION IMPLANTATION APPARATUS FOR PROCESSING SEMICONDUCTORS. Tsuchimoto, T.; Tokuyama, T.; Ikeda, T. (Hitachi Ltd., Tokyo). pp 531-44 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

An ion-implantation apparatus for both processing research and small-scale pilot production of semiconductor devices was constructed. This system is designed to implant boron and phosphorous ions into silicon substrates up 200 keV and has the following specifications: higher output analyzed ion-beam density (1 A/cm^2), broad-area scanning (100 cm^2) and quick exchange of substrates with heated or cooled tray. The operating characteristics under various conditions are discussed in detail. (auth)

10270 USE OF AN ELECTRON MICROPROBE TO STUDY ION IMPLANTATION. Legrand, Ch.; Trillat, J. J. (CNRS, Bellevue, France). pp 545-52 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

An electron microprobe can be used efficiently to control the implantation of ions in the bombarded targets. In the case of thin films, the sputtering rate can be studied. Argon ions of energy between 5 and 30 kV were implanted in Al, Ni, and Au, and the effects of heat treatment on the implant were studied. (TSS)

10271 ION IMPLANTATION USING AN ION IMAGE. Bernheim, M. (Faculte des Sciences, Orsay, France). pp 553-62 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

An ion-image apparatus derived from one used for micromachining by ion sputtering, is used in order to avoid the need for masking in doping semiconductors. It consists essentially of an electrostatic lens which focuses an image of the doping ions of a model (perforated structure). The ion optics is accomplished by a reducing lens. A double magnetic prism makes it possible to use two ion sources to dope successively P and N in different regions. An ion–electron image converter is used to produce an image on a fluorescent screen for checking focus. Some preliminary experimental results are given. (D.L.C.)

10272 SPATIAL DISTRIBUTION OF ENERGY DEPOSITED BY ENERGETIC HEAVY IONS IN SEMICONDUCTORS. Tsurushima, Toshio; Tanoue, Hisao (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap.; 31: No. 6, 1695-1711(Dec 1971).

A new general principle is described that provides a simple and direct method for predicting the spatial distribution of energy absorbed in nuclear collisions, especially in atomic displacement processes in heavy-ion-bombarded semiconductor materials. To calculate the energy transfer rate into atomic displacements, an energy distribution function of incident ions at an arbitrary penetration depth is derived and integrated together with a weight function made from the total cross section for the production of displaced atoms and the average energy transfer corresponding to those encounters that can displace atoms in the substrate materials. Numerical data obtained in each procedure of the method are presented and compared with the results revealed by many theoretical and experimental works attempted up to present. The average number of knock-on atoms produced by an incident ion and associated knock-ons is calculated in a unique manner. Problems of the vacancy distribution and the amorphization criterion are also discussed. (auth)

10273 TEMPERATURE DEPENDENCE OF THE MINIMUM YIELD IN CHANNELING PHENOMENA. Komaki, K. (Tokyo Univ.); Fujimoto, F.; Ishii, M.; Nakayama, H. Phys. Lett.; 37A: No. 4, 271-2(6 Dec 1971).

The temperature dependence of the minimum yield in channeling phenomena along the ⟨110⟩ and ⟨111⟩ axes was measured in germanium and silicon crystals. The observed values agree well with those obtained by computer simulation. .(auth)

10274 IS ISOTHERMAL DEFERRED LUMINESCENCE IN ORGANIC GLASSES DUE TO ELECTRON TUNNELING? Kieffer, F.; Meyer, C.; Rigaut, J. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 11: No. 3, 359-61(15 Oct 1971).

In γ-irradiated methylcyclohexane glass containing biphenyl, isothermal luminescence (ITL) (at 4.2, 66 and 77°K) and the first thermoluminescence peak (90°K) result from the recombination of cations with two different populations of trapped electrons, apparently characterized by different detrapping mechanisms: electron tunneling in ITL and thermal disruption of traps in the first glow peak. (auth)

10275 ION IMPLANTATION AND ITS APPLICATIONS. REVIEW OF CURRENT RESEARCH AND DEVELOPMENT. Tsurushima, Toshio; Tanoue, Hisao (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku; No. 171, 1-122(Dec 1970). (In Japanese).

Interest in ion implantation as a practical method for controlling electrical and other physical characteristics of semiconductor material, as well as for fabricating semiconductor devices, has been growing rapidly for several years. A review is presented of current research and development in the field of ion implantation. (TSS) (Japan)

10276 ATOMIC DISPLACEMENTS BY ELECTRON IRRADIATION IN PYROLYTIC GRAPHITE. Iwata, Tadao; Nihira, Takeshi (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 31: No. 6, 1761-83(Dec 1971).

The anisotropic threshold energy for atomic displacements and the displacement cascade process in electron-irradiated pyrolytic graphite are studied in the energy range from 0.12 to 1.0 MeV at three different temperatures by observing the a-axis electrical resistivity increases. The threshold energy T_d is represented as $T_d(\Psi) = A\cos^2\Psi + B\sin^2\Psi + C(1-\cos 4\Psi) \equiv (A, B, C)$ in eV, where Ψ is the angle between the c-axis and the displacement direction. In the 6 and 80°K irradiations, T_d is given as a set of (23, 30, 0) and (31, 30, −2) ± 2 eV, and the cascade obeys the Harrison–Seitz replacement model for $\Theta = 0°$, but obeys the Kinchin–Pease model for $\Theta = 90°$, where Θ is the angle between the c-axis and the electron direction. In the 285°K irradiations T_d is either (28, 42, 0) ± 2 eV, or a set of (28, 42, 0) and (32, 42, −1) ± 2 eV, and the cascade obeys the Harrison–Seitz (no replacement) model for $\Theta = 0$, 30, 60, and 90°. The effects of crystal structure, lattice vibrations, and thermal annealings are discussed using these results. (auth)

10277 RADIATION-PRODUCED ABSORPTION BANDS IN SILICON: PIEZOSPECTROSCOPIC STUDY OF A GROUP-V ATOM-DEFECT COMPLEX. Chen, C. S. (Rensselaer Polytechnic Inst., Troy, N. Y.); Corelli, J. C.; Watkins, G. D. Phys. Rev., B; 5: No. 2, 510-26(15 Jan 1972).

A series of sharp new infrared-absorption bands produced by high-energy-electron irradiation in phosphorus- and arsenic-doped float-zone-refined silicon is reported. In P-doped silicon, the dominant band is at 1150 cm^{-1}, with associated weaker bands at 1310, 970, 1000, 1025, 1040, and 1450 cm^{-1}. In As-doped silicon, the corresponding bands are at 1260 cm^{-1} and 1480, 1080, 1110, 1135, 1160, and 1650 cm^{-1}. The spectra recover in both materials at ~140°C. Uniaxial-stress studies of these bands in oriented single crystals with polarized light are described. The results cannot be fit to the usual "piezospectroscopic" classification of Kaplyanskii and Runciman. A model is presented which identifies the spectra as electronic transitions from the orbital singlet ground state of a single anisotropic donor defect to a manifold of bound large-orbit effective-mass excited states. Extension of the Kaplyanskii classification to include the accidental degeneracy inherent in the effective-mass excited states in silicon explains the stress results. The symmetry of the defect is deduced to be monoclinic II. It is deduced that one or more group-V atoms are involved in the defect, but a microscopic identification of the defect is not possible. (auth)

10278 PRODUCTION OF PHOTOCHROMIC BANDS FROM DIPOLE CENTERS IN IRRADIATED CaF_2:Ce. Wagner, J.; Mascarenhas, S. (Escola de Engenharia, Sao Paulo, Brazil). Phys. Rev. Lett.; 27: No. 22, 1514-16(29 Nov 1971).

The method of ionic thermocurrents was combined with optical-absorption and radiation-damage techniques to investigate the production of photochromic centers in CaF_2: Ce. It is found that the initial growth of the photochromic bands under x irradiation is correlated with the destruction of the 243-nm band initially, and with an exponential decay of dipole centers at later stages. The maximum oscillator strength of the 243-nm band is calculated. It is also found that one photochromic center is formed for each four dipole centers destroyed, independent of dose rate. (auth)

10279 IRRADIATION DAMAGE AND SEMICONDUCTING PROPERTIES OF CdF_2:Eu. Tzalmona, A.; Pershan, P. S. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 55: No. 10, 4804-11(15 Nov 1971).

Thermoluminescence data were used to unravel the fluorescence spectrum of Eu^{3+} in the insulating CdF_2 host. Optical absorption and EPR measurements of semiconducting CdF_2: Eu are the bases of a model of this semiconductor. (auth)

10280 ESR SPECTRA FROM PARAMAGNETIC CENTERS IN IRRADIATED $KBrO_4$. Byberg, J. R. (Aarhus Univ., Denmark). J. Chem. Phys.; 55: No. 10, 4867-72(15 Nov 1971).

ESR spectra of $KBrO_4$ crystals irradiated with x rays at 10 or 26°K contain three "families" of intense signals. The signals observed at 10°K are assumed to derive from primary defects constituted by electrons and holes trapped on BrO_4^- ions. The families of signals are assigned to the species BrO_4^{2-}, BrO_4, and $(BrO_4)_2^-$, each trapped in a number of distinct sites. Thermal processes starting at 20°K result in formation of the secondary defects O_3^- from BrO_4^{2-}, and BrO_2 from BrO_4. (auth)

10281 GERMANIUM–HYDROGEN–LITHIUM CENTER IN α-QUARTZ. Weil, John A. (Argonne National Lab., Ill.). J. Chem. Phys.; 55: No. 10, 4685-98(15 Nov 1971).

A new center, denoted by $GeHLi_2$, was observed by EPR to be present in alpha-quartz containing germanium, after room-temperature x irradiation. The spin Hamiltonian at 8909 MHz and 300°K was measured, yielding the Zeeman splitting tensor $\bar{g}$ and the hyperfine coupling tensors $\bar{A}(^{73}Ge)$, $\bar{A}(^1H)$, $\bar{A}(^7Li_1)$, and $\bar{A}(^7Li_2)$. From the principal values and axis directions, a model for the center of the form $Ge^{3+}H^-(Li^+)_2$ was derived. This postulates germanium to be present substitutionally at a silicon site, with the hydride and two lithium ions occurring interstitially nearby. The unpaired electron is thought to be in a Ge orbital $a(4s) + b(4p)$, with $|a|^2 \sim 0.18$ and $|b|^2 \sim 0.35$, with considerable spin density also at the hydrogen. The center may be formed from a diamagnetic precursor $Ge^{2+}(Li^+)_2$ by reaction with a hydrogen atom. (auth)

10282 ION BOMBARDMENT AND THERMAL RELEASE OF NOBLE GASES FROM STRAIN-FREE AND STRESSED NIOBIUM SINGLE CRYSTALS. Rantanen, Raymond Onni. Pullman, Wash.; Washington State Univ. (1971). 72p. University Microfilms Order No. 71-28,793.

Thesis.

The (100) and the (111) faces of niobium single crystals were bombarded with noble-gas ions having kinetic energies between 100 and 1500 eV. Peaks in the thermal reemission spectra of helium and argon from the clean (100) and (111) faces of niobium single crystals were found. Stressing a niobium bar with a [100] orientation, then bombardment–desorption with helium changed the relative peak height of the peak near 3.0 eV and the peak at 1.61 eV. This technique appears to be useful in determining the mechanisms responsible for release of buried gases. Activation energies of annealing mechanisms found in the literature are: vacancy migration, 1.3 eV; surface self-diffusion, 2.37 eV; and self-diffusion, 4.4 eV. Peaks that correspond to these energies were found as well as others. Samples that had been exposed to air after bombardment exhibited drastic changes in the resulting helium desorption spectra. (Diss. Abstr. Int., B)

10283 CHANNELING IN IRON AND LATTICE LOCATION OF IMPLANTED XENON. Feldman, L. C.; Murnick, D. E. (Bell Labs., Murray Hill, N. J.). Phys. Rev., B; 5: No. 1, 1-6(1 Jan 1972).

A study was made of heavy-ion (^4He, ^{12}C, ^{14}N) channeling in carefully prepared iron single crystals. Angular distributions and critical angles in good agreement with the Lindhard theory were obtained. $^{131,132}Xe$ was implanted into the iron crystal at 100 or 200 keV in a random direction at doses of (1 to 100) $\times$ 10^{14} atoms/cm^2. In all cases, some radiation damage was evident from an increase in the minimum channeling yield. Typically (50 ± 10)% of implanted Xe was found to be at lattice sites at low doses, while most of the atoms were not substitutional at higher doses. Annealing at 450°C reduced the substitutional fraction; annealing at 300°C did not. These data are compared with Moessbauer-effect studies of hyperfine fields on Cs in iron. (auth)

10284 CONTROL OF POSITIVE SURFACE CHARGE IN Si/SiO_2 INTERFACES BY USE OF IMPLANTED Cs IONS. Sixt, G.; Goetzberger, A. (Fraunhofer-Gesellschaft, Freiburg i. B.). Appl. Phys. Lett.; 19: No. 11, 478-9(1 Dec 1971).

Cesium is shown to give positive surface charge, which has great stability against temperature-bias stressing. Cesium ions are first introduced into Si surfaces by ion implantation, then the surface layer is converted into SiO_2 by thermal oxidation. Surface charge can be well localized by masking. Its magnitude depends on the number of implanted ions, on oxidation time, and temperature. (auth)

10285 RADIATION DAMAGE STUDIES USING THE LOW-TEMPERATURE IRRADIATION FACILITY. VII. NEUTRON IRRADIATION OF p-TYPE GERMANIUM AT LOW TEMPERATURE. Saito, Haruo; Fukuoka, Noboru; Tatsumi, Yukichi; Yoshida, Hiroyuki; Nakagawa, Masuo. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 123-5(1971).

Ga- and In-doped Ge were irradiated at ~70°K in the Kyoto Univ. reactor to a fast neutron fluence of 3×10^{14} nvt/cm^2. Isochronal annealings (20 min) were carried out at 80 to 400°K. Five annealing stages were observed; the largest recovery occurs in the stage between 170 and 220°K, and the conductivity recovers to its pre-irradiation value above 400°K. An interpretation of the meaning of the curves in terms of electron traps is offered. (D.L.C.)

10286 GAS-RELEASE STUDIES OF SILICON IMPLANTED WITH LOW-ENERGY He^+ AND Kr^+ IONS. Davies, A. L. M.; Carter, G. (Univ. of Salford, Eng.). Radiat. Eff.; 10: No. 4, 227-33(Sep 1971).

A silicon (111) surface was bombarded in ultrahigh vacuum with low-energy (≤1 keV) He^+ and Kr^+ ions. The ions retained within the solid were subsequently desorbed into a closed volume by raising the target temperature linearly, with respect to time, at a rate of 30°K/sec. The differentiated signal in a mass spectrometer provided desorption spectra. Two main release stages were noted, at ~400 and ~1000°K. It is suggested that the former is related to divacancy motion, modified by the presence of gas and the latter to the annealing of bombardment-induced amorphousness. Helium was injected into a target that had been amorphized by prebombardment with krypton ions. The helium was largely released in the ~400°K stage, and it was deduced that helium diffused through an amorphous layer at temperatures well below those required to anneal the amorphousness. (auth)

10287 LASER BLEACHING OF F CENTRES IN ELECTRON-IRRADIATED KBr. Redman, M. J.; Tubbs, M. R. (Univ. of Warwick, Coventry, Eng.). Phil. Mag.; 24: No. 191, 1059-77 (Nov 1971).

Experiments are described in which fast electron-induced color centers in single-crystal KBr are optically bleached by illumination at room temperature with light from a focused helium–neon laser. Illuminating power densities up to 10 kW cm^{-2} are used to bleach F centers present in concentrations of 10^{18} to 10^{19} centers cm^{-3}. The kinetics of bleaching under these conditions are similar for a wide variety of samples, dF/dE varying approximately as E^{-1} over six decades of absorbed energy E. The mechanism of bleaching at room temperature for crystals colored at liquid nitrogen temperature involves only vacancy–interstitial recombination, whereas crystals colored at room temperature bleach solely by the random aggregation of F centers. A new modulation technique is used to show that R^+ centers are formed during illumination, and this points to the importance of F-α and M-α mechanisms for aggregation in the later stages of bleaching. (auth)

10288 THEORETICAL TREATMENT OF ION ENTRAPMENT IN SITES ASSOCIATED WITH RADIATION DAMAGE. Davies, A. L. M. (Univ. of Salford, Eng.). Radiat. Eff.; 11: No. 1, 9-14(Oct 1971).

The entrapment of gas atoms at damage sites created during their injection as energetic ions into a solid, is treated theoretically. A general treatment is indicated and a special theory, based on the assumption that the spatial distribution of traps is uniform, is developed. The special theory leads to analytical solutions, which are dependent on the initial spatial distribution of free thermal gas (i.e., the "range profile"). Three cases are considered (plane, xe^{-x}, and e^{-x} distributions). It is shown that the assumed model provides that the amount of gas trapped in the solid is initially proportional to the $\frac{3}{2}$-power of the ion fluence. (auth)

10289 ELECTRICAL PROPERTIES OF INDIUM-IMPLANTED SILICON. Pashley, R. D. (California Inst. of Tech., Pasadena). Radiat. Eff.; 11: No. 1, 1-8(Oct 1971).

Electrical conductivity and Hall effect were measured from 100 to 278°K as a function of layer removal to determine the indium ionization energy and the presence of compensating centers resulting from the implantation of indium into silicon. The implants were fully annealed to reduce the influence of radiation damage. For comparison, similar measurements were performed on silicon shallow diffused with indium. Differential analysis methods were used to compute carrier concentration, mobility, and resistivity for the stripped layers. In addition, Hall measurements were performed on silicon uniformly doped with indium. In all three cases, an indium energy level of 160 MeV was observed. Mobility plots versus temperature were also consistent. However, significant compensation effects were noticed in the implants. (auth)

10290 COLOUR CENTRES IN LOW TEMPERATURE GAMMA RADIOLYSIS OF POTASSIUM FLUORIDE CRYSTALLINE HY-

DRATES. Puntezhis, S. A.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Radiat. Eff.; 10: No. 4, 253-8 (Sep 1971).

Gamma irradiation of $KF \cdot 2H_2O$ and $KF \cdot 4H_2O$ crystalline hydrates at low temperatures results in the appearance of color centers. The characteristics of optical spectra of these centers at 77°K are: λ_{max} = 475 nm and $W_{\frac{1}{2}}$ = 0.58 eV for $KF \cdot 2H_2O$; λ_{max} = 480 to 485 nm and $W_{\frac{1}{2}}$ = 0.62 eV for $KF \cdot 4H_2O$. The EPR spectrum of color centers is an isotropic singlet with g-factor 2.001 and ΔH = 34.5 Oe (for $KF \cdot 2H_2O$ at 77°K). Their yields are low (0.015 and 0.0055 particles/100 eV for $KF \cdot 2H_2O$ and $KF \cdot 4H_2O$ at 77°K, respectively). The kinetics of their accumulation at γ irradiation as well as the kinetics of thermal and photostimulated decay was investigated. On the basis of the data obtained, it was concluded that the color centers in crystalline hydrates investigated are similar in their nature to F centers in alkali halide crystals, but differ from trapped electrons in glassy aqueous solutions. (auth)

10291 THEORY OF REGULAR ARRAYS OF DEFECTS: THE VOID LATTICE. Stoneham, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., F (London); 1: No. 6, 778-84(Nov 1971).

Defects in crystals may form a regular array, rather than a random distribution. The lattice of voids produced in irradiated molybdenum is a remarkable example of this. A general method of calculating the energy per defect in the array is given, which exploits the periodicity of the defect lattice. The existence of the void lattice depends on the elastic interaction between voids. The present approach can treat both arbitrarily anisotropic elastic continua and discrete lattices, and is readily extended to discuss the stability of the defect lattice. The results predict that a void lattice should occur in molybdenum, and a number of models for the void are compared. Stability against shear of the void lattice is not discussed. The ratio of the void lattice spacing to void radius predicted is 2.2 to 4.5 and is smaller than the value of about 10 observed. The results are in general agreement with the more approximate Malén–Bullough treatment. (auth)

10292 RADIATION EFFECT ON THE ADSORPTION CAPABILITY OF ZnO AND MgO. Ermatov, S. E.; Kusainov, S. K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 56-7(Mar-Apr 1971). (In Russian).

The effect of slow electrons on the adsorptive properties of ZnO and MgO was studied, and an increase in the adsorption of O_2 and CO_2 on ZnO was noted. In contrast, a desorptive process predominates in the behavior of MgO with these gases. A possible mechanism is offered. (tr-auth)

10293 EFFECT OF β-RADIATION ON THE ADSORPTION CAPABILITY OF UNADULTERATED SILICA GEL. Ermatov, S. E.; Vakhabov, M. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 57-60(Mar-Apr 1971). (In Russian).

The effect of β-radiation on the supplementary adsorption of commercial and pure silica gel was studied. The adsorption capability of silica gel significantly increased with respect to O_2 and CO_2. Contaminating materials evidently did not affect the sorptive properties of silica gel. (tr-auth)

10294 EFFECT OF IONIZING RADIATION ON THE ADSORPTIVE ABILITY OF SOLID BODIES. Ermatov, S. E. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 60-2(Mar-Apr 1971). (In Russian).

A survey was made of studies of the adsorptive and catalytic properties of dielectrics and semiconductors under the influence of different forms of irradiation. The adsorptive capability of solids depend on the energy of the bombarding particles. (tr-auth)

10295 ENHANCED DIFFUSION OF ION-IMPLANTED ANTIMONY IN SILICON. Gamo, Kenji; Iwaki, Masaya; Kawasaki, Kiyoshi; (and others). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 9-16(1971).

Concentration profiles of antimony implanted in silicon single crystals are measured by radioactivation analysis, and defects produced by implantation are observed by ESR and electron-diffraction measurement. It is found that the diffusion of antimony is markedly enhanced during annealing after room-temperature implantation and during high-temperature implantation and that the enhancement of diffusion is independent of temperature. The diffusion coefficient is obtained by analytical calculation, and the measured concentration profiles are found to agree very well with the calculated concentration profiles. These results are explained on the basis of a vacancy mechanism. (auth)

10296 F-CENTER LUMINESCENCE DURING X-RAY IRRADIATION IN KCl. Matsuyama, Tomochika; Hirai, Masamitsu. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 66-8(1971).

KCl single crystals were irradiated with 45-kV x rays at low temperatures. The infrared luminescence spectrum at 4.2°K was found to have a peak at 1.16 eV with a half width of 0.27 eV, and peak positions and half widths for irradiations at 77 and 194°K are given. Several possible mechanisms for the F-center luminescence are described. (D.L.C.)

10297 RADIATION DAMAGE STUDIES USING THE LOW-TEMPERATURE IRRADIATION FACILITY. VIII. COLOR CENTERS IN $PbCl_2$ CRYSTAL. Nishi, Masato; Fujii, Atsuhiro; Kato, Shohichi; (and others). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 126-7(1971).

$PbCl_2$ single crystals were irradiated in the KUR at 70 ± 20°K to a dose of 3.2×10^{15} nvt. The absorption spectrum, measured before warming above 77°K, showed four peaks at 440, 700, 920, and 1050 nm. All four peaks were bleached on warmup. (D.L.C.)

10298 RADIATION DAMAGE STUDIES USING THE LOW-TEMPERATURE IRRADIATION FACILITY. IX. ABSORPTION BANDS IN PURE CaF_2 CRYSTALS. Atobe, Kozo; Nakagawa, Masuo; Okada, Moritami; (and others). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 128-31(1971).

The effects of neutron irradiation (~10^6 nvt) at 20 and 70°K on the absorption spectrum of CaF_2 crystals were studied. The behavior of the spectrum on warming to room temperature and annealing at 380°C was studied, and the temperature dependence of the bands were determined. The process of coloration at 20°K differs from that at 70°K. (D.L.C.)

10299 RADIATION DAMAGE STUDIES USING THE LOW-TEMPERATURE IRRADIATION FACILITY. X. RESISTIVITY CHANGES OF Cu–Be ALLOYS DURING HIGH TEMPERATURE IRRADIATION. Yoshida, Hiroyuki; Sagane, Toshimitsu. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 132-4(1971).

High-temperature irradiation was performed at 100 to 160°C, using heaters in the KUR irradiation facility. At the higher temperatures, a shorter time was required to reach the resistivity maximum, and lower resistivity values were obtained at longer times. The results suggest that, for the supersaturated specimens, the increase in resistivity corresponds to the process of Guinier–Preston zone formation, and the rapid decrease at 160°C is due to precipitation of equilibrium γ phases. (D.L.C.)

10300 RADIATION DAMAGE STUDIES USING THE LOW-TEMPERATURE IRRADIATION FACILITY. XI. DEFECTS OBSERVED IN PURE GOLD AND ALUMINUM IRRADIATED WITH NEUTRONS AT 20°K. Shimomura, Yoshiharu; Uefuji, Tateki; Yoshida, Hiroyuki; Kino, Takao. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 135-9(1971).

Electron microscopy was used to study the nature of defects formed in Au and Al foils irradiated in the KUR at 20°K. The irradiations were carried out in the tip and middle positions for high and low doses. The defect was tentatively determined to be an interstitial cluster, and the average density was 10^{15} and 4×10^{14} cm^{-3} for high- and low-dose irradiations, respectively. The size was 30 and 20 Å for high and low doses. The effects of annealing up to 600°C were also studied. The results are compared with these for 130°K electron irradiation of Au. (D.L.C.)

10301 X-IRRADIATION EFFECTS AT LIQUID-NITROGEN AND ROOM TEMPERATURES ON COLORATION OF AMMONIUM IODIDE. Podszus, B. (Univ., Freiburg i. B.). Z. Naturforsch.; 26a: No. 7, 1181-6(Jul 1971). (In German).

V_K centers were produced by x irradiation of ammonium iodide at liquid-nitrogen temperature and studied by reflection and luminecence measurements. Pulse annealing experiments showed that the I_2 centers were unstable above ~100°K. The 3.3-eV absorption band was investigated by means of reflection measurements. (auth)

10302 DEFECTS IN NEUTRON-IRRADIATED ZnO. I. Leutwein, K.; Schneider, J. (Institut fuer Angewandte Festkoerperphysik, Freiburg i. B.). Z. Naturforsch.; 26a: No. 7, 1236-7(Jul 1971).

After irradiation with fast neutrons, several paramagnetic centers were observed in ZnO by ESR. They result from electrons trapped at oxygen vacancies and from holes trapped at more complex defects. (auth)

10303 EXPERIMENTAL EVIDENCE OF FINE STRUCTURE IN CHANNELING LINES. Lutz, H. O.; Ambros, R.; Mayer-Boericke, C.; Reichelt, K.; Rogge, M. (Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch.; 26a: No. 7, 1105-8(Jul 1971).

Fine structure was found in the angular distribution of 2-MeV He ions channeled between the (001) planes of 1600- to 3000-Å-thick Au single crystals. In addition, the energy loss of the channeled particles was determined as a function of exit angle from the crystal. (auth)

10304 F CENTRE IN MgF_2. II. OPTICAL ABSORPTION AND EPR. Kolopus, J. L. (Oak Ridge National Lab., Tenn.); Lewis, J. T.; Unruh, W. P.; Nelson, L. G. J. Phys., C (London); 4: No. 17, 3007-14(Dec 1971).

The 260-nm optical absorption band in irradiated MgF_2 has been identified as the F band. The irradiation dose dependence, irradiation temperature dependence, optical bleaching behavior, and thermal annealing properties of this band and the EPR F center were compared, using the same samples for both the optical and EPR work. A close correlation of all the properties measured with both techniques established that, in irradiated MgF_2, the 260-nm band is indeed the F band with an oscillator strength of approximately one. (auth)

10305 F CENTRE IN MgF_2. I. EPR AND ENDOR. Unruh, W. P. (Univ. of Ohio, Athens); Nelson, L. G.; Lewis, J. T.; Kolopus, J. L. J. Phys., C (London); 4: No. 17, 2992-3006 (Dec 1971).

The magnetic resonance absorption at g = 2 in irradiated MgF_2 is positively identified as arising from F centers. EPR and ENDOR investigations determined the hyperfine constants and tensor axis orientations for the first six fluorine shells. These agree in detail with the interactions expected from an electron trapped at a negative-ion vacancy. The large nearest-neighbor interaction ($A_{||}$ = 382.83 MHz, $A_{\perp}$ = 288.23 MHz) coupled with the smaller second- and third-neighbor interactions were used to reconstruct in detail the resolved EPR spectra when H_0 is parallel to the crystal symmetry axes. A semi-empirical wave function obtained from the observed contact interactions for all six shells predicts that nearest-neighbor cation ENDOR transitions for the 10%-abundant ^{25}Mg nuclei should be observed near the first-neighbor fluorine transitions. (auth)

10306 RAPID PROFILE MEASUREMENTS IN ION-IMPLANTED SILICON. Davidson, S. M. (Oxford Univ.). J. Phys., E (London); 5: No. 1, 23-6(Jan 1972).

Ion-beam etching was used, in conjunction with the Van der Pauw technique, to determine the electrical profiles of implanted dopants in silicon, the profiles being obtained much more rapidly than by using the more usual anodic stripping. The damage produced by the ion beam must be taken into account, and this involves a simple correction to the depth scale. Profiles obtained for 40-kV B^+ implanted silicon, annealed at temperatures between 500 and 970°C, are presented and briefly discussed. (auth)

10307 ROLE OF ENTROPY IN THERMALLY ACTIVATED DEFORMATION: APPLICATION TO THE STUDY OF IRRADIATION HARDENING IN LiF. Cagnon, M. (Faculte des Sciences, Orsay, France). Phil. Mag.; 24: No. 192, 1465-76(Dec 1971).

An experimental study of low-temperature deformation of irradiated lithium fluoride is presented. Results are discussed in terms of the rate process theory, and it is shown that only the entropy contribution arising from the temperature dependence of the shear modulus is needed to give a self-consistent analysis of the experimental data. On that basis, a new procedure to determine the Gibbs free energy from the stress dependence of activation volume is outlined. (auth)

10308 EFFECT OF LOW-ENERGY He^+ ION INJECTION ON THE SURFACE STRUCTURE OF ORDERED Ni-BASE ALLOYS. Duquette, D. J.; Krutenat, R. C. (Pratt and Whitney Aircraft, Middletown, Conn.). Phil. Mag.; 24: No. 192, 1411-21(Dec 1971).

Single crystals of a commercial, high-strength nickel alloy and structurally analogous crystals of Ni–9 wt % Al were bombarded with low-energy (<5 keV) He^+ ions. An extensive defect structure consisting of intrinsic stacking faults, tangled dislocations and, in the case of the commercial alloy, carbide precipitation, was observed by transmission electron microscopy in and near the alloy free surfaces. This defect production can be attributed to a dynamic interaction of injected He atoms with the alloy crystal structure. (auth)

10309 SECTIONING TECHNIQUE FOR SODIUM CHLORIDE SINGLE CRYSTALS AND ITS APPLICATION FOR ION-IMPLANTATION STUDIES. Andersen, T.; Ebbesen, A. (Univ. of Aarhus, Denmark). Radiat. Eff.; 11: No. 2, 113-18(Nov 1971).

A sectioning technique for sodium chloride single crystals was developed. This technique, which is based on the formation of a silver chloride film, is capable of removing layers of constant thickness up to 2 $\mu g/cm^2$. Being insensitive to radiation damage of the NaCl surface, this film technique can be applied in studies of penetration and diffusion in NaCl. An electromagnetic isotope separator was used to implant radioactive phosphorous, krypton, and xenon atoms in single crystals of sodium chloride, and examples are shown where the film technique was applied for the study of range distributions and diffusion processes. (auth)

10310 ELECTRON IRRADIATION AT 0.5 MeV FOR COPPER SINGLE CRYSTALS. Pruitt, A. B.; Chaplin, R. L. (Clemson Univ., S. C.). Radiat. Eff.; 11: No. 2, 119-21(Nov 1971).

Results of isochronal anneals following electron irradiation of copper single crystals indicate the I_B recovery is enhanced for a ⟨100⟩ sample compared to the I_B recovery for a ⟨110⟩ sample and a polycrystal sample. Comparison of these results with data from aluminum single crystals indicates a tentative assignment of the I_B defect in copper to damage produced in the ⟨100⟩ direction. (auth)

10311 POSITRON ANNIHILATION IN THE SOLID STATE. Tumosa, Charles Stephen. Blacksburg, Va.; Virginia Polytechnic Inst. and State Univ. (1972). 126p. University Microfilms Order No. 71-31,033.

Thesis.

Positron annihilation was used to follow the effects of ionizing radiation on single crystals of sodium chloride. These effects are compared to results obtained by studying the positron annihilation in doped crystals having cation and anion vacancies. The results of these experiments are interpreted by postulating a positron–defect bound-state model and deriving the kinetic equations for this process. The technique of positron annihilation was also used to study the reaction of orthopositronium with substituted aromatic hydrocarbons adsorbed on the surface of silica gel. The positron-decay behavior was interpreted by postulating two distinct mechanisms involving inhibition of positronium formation and a free volume effect. (Diss. Abstr. Int., B)

10312 ESR OF FREE RADICALS IN FERROELECTRIC AND ANTIFERROELECTRIC ARSENATE SINGLE CRYSTALS. Gaillard, J.; Constantinescu, O.; Lamotte, B. (CEN, Grenoble, France). J. Chem. Phys.; 55: No. 12, 5447-52(15 Dec 1971).

The electron spin resonance of gamma-irradiated single crystals of KH_2AsO_4, KD_2AsO_4, $NH_4H_2AsO_4$, and $ND_4D_2AsO_4$ has been investigated. New paramagnetic centers present in several varieties and which exhibit a strong coupling with one ^{75}As atom have been described. At room temperature, their g tensor is nearly isotropic and their hyperfine couplings are axially symmetric. The annealing of these centers is examined and their behavior upon cooling down below T_c is described. All these centers which seem to belong to the same family have been identified as AsO_3^{2-} species. Their different varieties must be ascribed to different environments coming either from various proton environments or from several associations with varied impurities. (auth)

10313 GEMINATE RECOMBINATION OF X-RAY-EXCITED ELECTRON–HOLE PAIRS IN ANTHRACENE. Hughes, R. C. (Sandia Labs., Albuquerque, N. Mex.). J. Chem. Phys.; 55: No. 12, 5442-7(15 Dec 1971).

A recent controversy is discussed concerning the relative importance of geminate and track recombination of charge carriers excited by ionizing radiation in single crystals of anthracene. Data are presented that strongly support the geminate recombination hypothesis for bulk excitation by x rays in the 50 to 500-keV range. In agreement with the earlier work of Kepler and Coppage, it is found that it requires about 2700 eV to create a pair of charge carriers in anthracene at an applied field of 10 kV/cm. (auth)

10314 ADHESION OF ADSORBED ATOMS DURING ION IRRADIATION OF METALLIC SURFACES. Radzhabov, T. D. pp 70-8 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The adhesion of adsorbed atoms to metal surfaces during the ion irradiation of the surface is discusssed from the theoretical and experimental points of view. Three possible mechanisms are considered: (i) the "ion-shock" hypothesis, in which the ions penetrate well into the metal under the influence of electrostatic forces, and then partly return to the gas phase, duly modified in energy distribution by the metal, (ii) the "surface" hypothesis, according to which sorption occurs as a result of Langmuir forces, and the effects of electrostatic acceleration are negligible and (iii) the "centers" hypothesis, in which the particles are adsorbed on "prepared sites" in the crystal lattice independently of the character of the ions. The first of these mechanisms appears to be dominant in the case of metals, the second appearing occasionally. The third only applies to such materials as silica gel. (Metals Abstr.)

10315 EFFECT OF ION IRRADIATION ON THE PHYSICAL AND PHYSICO-CHEMICAL PROPERTIES OF SILICON. Ablyaev, Sh. A.; Chirva, V. P.; Arsenin, V. V. pp 96-100 of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel. /Arifov, U. A. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1970). (In Russian).

The effect of ion irradiation (Li, B, Sb, and Cs ions with en-

ergies of up to 50 keV) on the physical and physico-chemical characteristics of Si crystals was studied, with special reference to the question of ionic doping and its use in semiconductor electronics. The irradiation of a Si surface with ions of the elements under consideration led to the creation of an inversion layer with rectifying properties, the depth of the layer being governed by the energy of the ions. The best values of rectification factor were obtained with Cs ions. Changes in the properties of the crystals under ion irradiation were attributed to two kinds of defect: true radiation damage (displaced atoms and vacancy aggregates) and interstitial defects (lattice impurities). (Metals Abstr.)

Physical Properties

Refer also to abstracts 8862, 9752, 9823, 9883, 9917, 10018, 10226, 10228, and 10903.

10316 (JINR-E2-6133) ROTATION OF PLANE OF LINEAR PHOTON POLARIZATION IN THE MAGNETIZED FERROMAGNETIC. Baryshevski, V. G.; Dumbrais, O. V.; Lyuboshitz, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 8p. Dep. NTIS (U. S. Sales Only).

10317 ANOMALOUS ELECTRICAL AND MAGNETIC CHANGES IN Cu-Cr BASE ALLOYS DURING PRECIPITATION. Szenes, G.; Kovacs, I.; Nagy, E. (Lorand Eoetvoes Univ., Budapest). Phys. Status Solidi (a); 7: No. 1, 251-4(16 Sep 1971).

The precipitation process in dilute Cu-Cr-Zr-Ce and Cu-Cr-Zr-Ti alloys was investigated by electrical resistivity and magnetic susceptibility measurements. The anomalous changes of the electrical resistivity and magnetic susceptibility observed during precipitation in both cold-worked and homogenized samples are believed to be the consequence of the formation of superparamagnetic precipitates of a certain critical size. (auth)

10318 MAGNETIC STUDIES ON TbFeAl. Oesterreicher, H. (Oregon Graduate Center, Beaverton). Phys. Status Solidi (a); 7: No. 1, K55-7(16 Sep 1971).

Magnetization measurements were carried out on TbFeAl at temperatures down to 3.8°K. The magnetic moment vs internal field plots show saturation at ~5 kOe at 100 and 160°K; S-type behavior begins to appear below 50°K, and inflection at 22 kOe occurs at 20, 10, and 6°K. A step increase of ~1.5 μ_B occurs at 4.5 and 4.2°K due to domain wall effects; at 3.8°K, it relaxes into a kink. A high remanence is left on decreasing the field in all cases. The temperature dependence of magnetization depends on the field. An ordering temperature of 185°K at a field of 20 kOe is indicated. (D.L.C.)

10319 INTERMETALLIC COMPOUNDS OF RARE EARTH ELEMENTS AND Ni, Co, OR Fe. Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands). Phys. Status Solidi (a); 7: No. 1, 199-210(16 Sep 1971).

A survey is given of the composition and crystal structure of existing rare earth-transition intermetallics. The relationship in crystal structure of the compounds RM_2, RM_3, R_2M_7, RM_5, and R_6M_{17} is briefly discussed (R and M represent a rare earth and 3d element, respectively). The variation of the magnetic moment of the M atoms and the variation of the Curie temperature brought about by the increase of the molar fraction of R in the various compounds are different for Ni, Co, or Fe. An attempt is made to explain these differences by means of Friedel's model of d-bands in transition metals. The R-M spin interaction is antiferromagnetic and leads in general to compensation points in the magnetization versus temperature curves. It is shown that these compensation points should vary with R as $g(g-1)J(J+1)$. This relation is obeyed for the compounds RFe_3 for which magnetic data and the lattice constants are given. A mechanism for the R-M exchange interaction is proposed. Magnetic data are also given for the compounds GdGa and $GdGa_{0.7}Cu_{0.3}$ isostructural with GdNi. (auth)

10320 FIELD IONIZATION CHARACTERISTICS OF INDIVIDUAL ATOMIC PLANES. Chen, Y. C.; Seidman, D. N. (Cornell Univ., Ithaca, N. Y.). Surface Sci.; 27: No. 2, 231-55 (Sep 1971).

A detailed study of the field ionization characteristics of nine different planes of tungsten in the (001)-(011)-(111) standard triangle was performed as a function of tip temperature (T_T) between 11 and 86°K, and local radius of curvature (r_T). The measured helium ion current-voltage characteristic curve for each plane was found to consist of two distinct regimes. The first regime was linear on a log-log plot, and the slope varied from 27 to 41. A modified version of Gomer's model for the very low field-ion current fitted the regime I data reasonably well. The second regime of each characteristic curve was quite complicated and exhibited several maxima and minima whose positions were functions of both T_T and crystallographic plane. A qualitative explanation for the behavior of the ion current in regime II was given in terms of a patch-field model consisting of three dominant spatial regions on the surface of the field-ion-microscope specimen. In addition, the explanation also considered the role played by a lateral supply of gas atoms on the specimen's surface, and a slowly increasing field-dependent radial supply function of gas atoms. It was also found that the probability of ionization was a strong function of both T_T and crystallographic plane. An expression was derived for the temperature dependence of this effect which fitted the data for atomically smooth planes [e.g., the (011) plane]. Finally, the ion current from individual planes was proportional to a power of r_T (at constant electric field) which varied between 2.3 and 2.9. This result was at variance with the existing theories of the supply function and indicated that the shank of the specimen was a significant source of imaging gas atoms. (auth)

10321 SURFACE-BARRIER ANALYSIS FOR NIOBIUM AND TANTALUM AND TANTALUM ON NIOBIUM FROM PERIODIC DEVIATIONS IN THE THERMIONIC SCHOTTKY EFFECT. Niehaus, W. C.; Coomes, E. A. (Univ. of Notre Dame, Ind.). Surface Sci.; 27: No. 2, 256-66(Sep 1971).

The Richardson emission constants and periodic deviations in the Schottky effect were used to investigate the surface barrier for thermionic electron emission from polycrystalline tantalum and niobium and thin films of tantalum-on-niobium. The data were fit to the Miller and Good theory and a Herring and Nichols complex reflection coefficient, μ, for the surface potential was determined. The following conclusions were drawn: the one-dimensional image nature of the barrier in the region of the barrier maximum was confirmed; the tantalum and niobium experimental amplitudes increased faster than predicted by the theory, indicating that either a field-dependent error exists in the theoretical ampiitude or the surface reflection process should be described by an energy-dependent reflection coefficient; and the average $\mu = 0.35 \exp(0.63i)$ for niobium and $\mu = 0.36 \exp(0.75i)$ for tantalum indicate that the Sommerfield surface bandwidth model proposed to fit the periodic deviations from molybdenum and rhenium is inadequate for tantalum and niobium. The controlled deposition of tantalum-on-niobium lowered the work function of niobium, and the experimental results confirm work on the molybdenum-on-rhenium surface alloy system that: (a) Richardson emission constants are strongly dependent on the micropatch distribution of the emitter surface, while (b) the periodic deviations parameters appear to be independent of it. (auth)

10322 STUDIES ON THE V_2O_5-MoO_3 SYSTEM: MAGNETIC PROPERTIES. Bielanski, A.; Dyrek, K.; Kracik, I.; Wenda, E. (Jagellonian Univ., Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 8, 513-21(1971).

The magnetic properties of the system $V_2O_5-MoO_3$ were investigated by Gouy's method in the temperature range 88 to 610°K and by EPR measurements at room temperature. Paramagnetic properties of all preparations except pure oxides were observed in the temperature range studied. The nonlinear dependence of magnetic susceptibility and of the number of spins on MoO_3 concentration is stated. These values change parallelly with V^{4+} concentration. The effective magnetic moment value and the spin number agree with the value expected for the V^{4+} ion of d^1 configuration. The deflection on the $1/\chi$-T plot of some samples indicated a phase transformation in the solid solutions of MoO_3 in V_2O_5 in the range 290 to 340°K depending on composition and in the MoO_3 phase at about 270°K. No such transformation was observed for the intermediate compound $V_9Mo_6O_{40}$. (auth)

10323 MAGNETIC SUSCEPTIBILITIES OF SOLID SOLUTIONS IN THE SYSTEM V_2O_3-Ti_2O_3. Perelyaev, V. A.; Shveikin, G. P. (Ural Inst. of Chemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 788-90(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 892-4(May 1971).

The temperature dependence of the magnetic susceptibilities of V_2O_3 and Ti_2O_3 was studied at 80 to 300°K. Resulting data are shown in the form of polytherms. (J.R.D.)

10324 INDIRECT EXCHANGE IN EuB_6. Wood, V. E. (Battelle Memorial Inst., Columbus, Ohio). Phys. Lett.; 37A: No. 4, 357-8(6 Dec 1971).

It is shown that positive paramagnetic Curie-temperatures in degenerate semiconductors such as EuB_6 may arise through either Bloembergen-Rowland or Ruderman-Kittel indirect exchange interactions. (auth)

10325 EuO FILMS DOPED WITH Fe AND Gd. Ahn, K. Y. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 1, 231-2(Jan 1972).

EuO films doped with Fe and Gd^{3+} raise the Curie temperature to ≳200°K (from 70°K for EuO). The magnetic moment is slightly reduced to 200 emu/g (vs 232 emu/g for EuO). The characteristic optical absorption band, which is due to an electronic transition from 4f to 5d levels of Eu^{2+} ions, remains unchanged with the peak absorption of 2.4×10^5/cm at 5800 Å. The longitudinal Faraday rotation at 6328 Å with an incident angle of 65° is 1.9×10^5 and 1.4×10^5 deg/cm at 7.0 and 77°K, respectively. Films deposited on several types of glasses possess square hysteresis loops with higher values of H_c (86 ~ 100 Oe at T < 10°K and less than 53 Oe at T = 77°K), both of which are essential for device applications. (auth)

10326 ANISOTROPIC DIFFUSION OF HYDROGEN IN NIOBIUM SINGLE CRYSTALS. Kistner, G.; Rubin, R.; Sosnowska, I. (EURATOM, Ispra, Italy). Phys. Rev. Lett.; 27: No. 23, 1576-7(6 Dec 1971).

Quasi-elastic neutron scattering experiments on hydrogen in niobium single crystals have been performed in $\vec{K}$ range from 1.7 to 4.3 $Å^{-1}$ in the three directions [100], [110], and [111]. The experimental width functions show a significant anisotropy. The results are not in agreement with the theoretical half-widths calculated for tetrahedral and octahedral positions of the hydrogen. (auth)

10327 EFFECT OF PRESSURE ON THE FERMI SURFACE OF ReO_3. Schirber, J. E. (Sandia Labs., Albuquerque, N. Mex.); Morosin, B.; Anderson, J. R.; Stone, D. R. Phys. Rev., B; 5: No. 2, 752-3(15 Jan 1972).

Pressure derivatives of several cross-sectional areas of the Fermi surface of ReO_3 were determined, as well as the isothermal compressibility at room temperature. The cross-sectional areas increase at rates of $(1.5 \text{ to } 4.0) \times 10^{-4}$ $kbar^{-1}$ compared to the free-electron scaling prediction of 3.6×10^{-4} $kbar^{-1}$. (auth)

10328 LATTICE THERMAL CONDUCTIVITY AND HIGH-FIELD ELECTRICAL AND THERMAL MAGNETOCONDUCTIVITIES OF TUNGSTEN. Wagner, D. K. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., B; 5: No. 2, 336-47(15 Jan 1972).

Measurements of the high-field transverse electrical and thermal conductivities σ_{xx} and κ_{xx} of a high-purity tungsten single crystal are presented for the temperature range 1.5 to 6°K. The magnetic field dependences of the conductivities conform excellently to the predictions of high-field semiclassical magnetoresistance theory, provided that thermal conduction by the lattice is taken into account. The results show that the lattice thermal conductivity is proportional to T^2, as expected for a pure metal in which the phonons are scattered principally by the conduction electrons. The temperature dependence of the high-field electrical conductivity σ_{xx} and the corresponding electronic contribution $(\kappa_e)_{xx}$ to the thermal conductivity κ_{xx} are also measured. Theoretical expressions for these quantities are derived from semiclassical magnetoresistance theory, allowing estimates to be made of the temperature dependence associated with possible low-temperature scattering mechanisms. Difficulties in interpreting previous zero-field measurements in terms of electron–electron or electron–phonon scattering are discussed. (auth)

10329 ELECTRONIC BAND STRUCTURE OF NIOBIUM NITRIDE. Mattheiss, L. F. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 5: No. 2, 315-20(15 Jan 1972).

The augmented-plane-wave method is applied to calculate the electronic band structure of niobium nitride (NbN). The results are qualitatively similar to those obtained from previous energy-band calculations for the 3d transition-metal monoxides which form with the same rocksalt structure. The Fermi level for NbN falls in the lower portion of the t_{2g} manifold of the niobium 4d bands so that the conduction electrons in NbN are predominantly 4d-like in character. These results are compared with some of the previous band-structure models that have been proposed to explain the electronic properties of NbN and other closely related refractory hard metals with the rocksalt structure. (auth)

10330 MAGNETIC PROPERTIES OF Ni–Fe–Nb ALLOYS. Masumoto, Hakaru; Murakami, Yuetsu; Hinai, Masakatsu (Research Inst. of Electric and Magnetic Alloys, Sendai). J. Jap. Inst. Metals; 35: No. 10, 985-8(Oct 1971). (In Japanese).

Measurements of magnetic properties, electrical resistivity, and hardness were carried out for Ni–Fe–Nb alloys at 72.98 ~ 84.67% Ni, 6.59 ~ 24.36% Fe, and 2.43 ~ 13.90% Nb heated in a pure hydrogen atmosphere at 1100°C for 3 hr and then cooled at various rates. It was found that the addition of Nb greatly improves the magnetic properties of Ni–Fe alloys. The highest values of 42,300 in initial permeability and 179,000 in maximum permeability were found for the compositions of 79.56% Ni, 12.04% Fe, and 8.40% Nb and of 79.62% Ni, 11.05% Fe, and 9.33% Nb, when cooled from a temperature above the order–disorder transformation point at a rate of 240°C/hr, respectively. The coercive forces of these two alloys for a maximum magnetic induction of 5000 G are 0.0107 and 0.0112 Oe, respectively, and the magnetic inductions in an effective magnetic field of 1000 Oe are 6550 and 5690 G, respectively. The electrical resistivity and Vickers hardness of the latter alloy are 69.5 μΩ-cm and 215, respectively. (auth)

10331 CONDENSATION OF HYDROGEN ON TUNGSTEN. Tamm, P. W.; Schmidt, L. D. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 55: No. 9, 4253-9(1 Nov 1971).

The condensation kinetics of hydrogen on the (110), (111), and (100) planes of tungsten are examined as functions of crystal temperature, coverage, and population of the various binding states. Measurements were carried out simultaneously on all three crystals in the same ultrahigh-vacuum system in order to accurately compare sticking coefficients and amounts adsorbed. There are large variations in the initial sticking coefficients s_0; at 78°K these vary between 0.26 on the (111) plane to 0.07 on the (110) plane. This implies that the electronic transition involved in bond formation depends sensitively on the geometric and electronic structures of the substrates. Also s_0 is observed to be almost independent of substrate temperature for all planes, showing that phonon-assisted processes do not determine the energy transfer. The coverage dependence of s shows considerable variation between states. In all cases a weakly adsorbed precursor state is involved, but the kinetics of conversion to the tightly bound states are quite different for different planes and states. Models are developed to explain condensation into multiple states for sequential and simultaneous population of the states on a plane, and these are compared with the experimental results. (auth)

10332 INTERACTION OF INDIVIDUAL METAL ATOMS ON TUNGSTEN SURFACES. Tien Tzou Tsong (Pennsylvania State Univ., University Park). J. Chem. Phys.; 55: No. 9, 4658-9(1 Nov 1971).

A field-ion microscopic study was made of the interaction between a W atom and a Re atom on a W (110) plane. The W atom can be made to migrate by heating to 300 to 340°K while the Re atom is kept at its original position. Thus, a W–Re bond is weaker than a W–W bond on a W (110) plane. Chains of 4-mers and many 2-mers of W were observed on W (211) planes, with the bond length occasionally changing from 4.47 to 5.24 Å. (D.L.C.)

10333 HYPERFINE MAGNETIC FIELD OF ARGON IMPLANTED IN NICKEL. Devare, H. G.; de Waard, H. (Rijksuniversiteit, Groningen, Netherlands). Phys. Rev., B; 5: No. 1, 134-7(1 Jan 1972).

The hyperfine field of argon in nickel was measured to be 280 ± 23 kG, using the technique of time-differential perturbed angular correlations. The argon nuclei were recoil-implanted in nickel by the $^{39}K(d,\alpha)^{37}Ar$ reaction. The second excited state of ^{37}Ar at 1610 keV was used in this measurement. The unperturbed α_2–1610-keV γ-ray angular correlation was studied with a copper backing for the target, and values $A_2 = 0.265 \pm 0.057$ and $A_4 = -0.222 \pm 0.098$ were obtained for the correlation coefficients. The amplitude of modulation of the time spectrum was found to be very small. This may be interpreted by assuming that the hyperfine field acts only on a small fraction of the implanted nuclei. (auth)

10334 TEMPERATURE DEPENDENCE OF THE HALL MOBILITY OF ELECTRONS IN GLASSY 10M NaOH ICE. Eisele, I.; Kevan, L. (Wayne State Univ., Detroit). J. Chem. Phys.: 55: No. 11, 5407-9(1 Dec 1971).

A double-modulation method was used to measure the electron Hall mobility in γ-irradiated alkaline ice (10 M NaOH). The temperature ranged from 80 to 133°K, and the Hall mobility at 80°K was determined to be 4.7 ± 1.9 cm^2 V^{-1} sec^{-1}; it decreases with temperature, indicating lattice phonon scattering. An Einstein temperature of 131°K for optical modes is estimated, but acoustical modes cannot be excluded. (D.L.C.)

10335 DIFFUSION OF SILICON INTO TUNGSTEN IN FIELD-EMISSION MICROSCOPE. Sinha, M. K.; Swenson, Orven F. (North Dakota State Univ., Fargo). Appl. Phys. Lett.; 19: No. 11, 493-4(1 Dec 1971).

When silicon is evaporated onto a tungsten field emitter at room temperature and the tip is then annealed at higher temperatures in order to carry out surface migration and thermal desorption studies, part of the silicon diffuses into the interior. When the tip is flashed at 2500°K to produce a clean surface, all the silicon is

not removed and it can be brought out again by annealing between 1000 and 1500°K. This is demonstrated by a silicon buildup on the surface with an activation energy of 9.3 ± 0.5 kcal/mole. The rate of buildup is enhanced by the application of high voltage. (auth)

10336 VIBRATIONAL ANALYSIS OF NEPTUNIUM (IV) HEXACHLORO COMPOUNDS IN CRYSTALLINE ENVIRONMENTS. Berringer, Burton Wayne. Pullman, Wash.; Washington State Univ. (1971). 87p. University Microfilms Order No. 71-28,748. Thesis.

The theory of molecular vibrations, both classical and quantum mechanical, is developed for $NpCl_6^{2-}$ ions in crystalline environments. These complex ions have symmetry O_h. Fourier transform spectroscopy is developed and applied to far-infrared spectroscopy. Finally, the theory developed is applied to dicesium neptunium hexachloride Cs_2NpCl_6, ditetramethyl ammonium neptunium hexachloride $[(CH_3)_4N]_2NpCl_6$, and ditetraethyl ammonium neptunium hexachloride $[(C_2H_5)_4N]_2NpCl_6$ in single-crystal and polycrystalline samples. Since the far-infrared spectrum provides only a portion of the available information, Raman spectra have also been obtained. The observed values at room temperature for far-infrared absorptions are: Cs_2NpCl_6—265 cm^{-1}, 117 cm^{-1}, and 58 cm^{-1}; $[(CH_3)_4N]_2NpCl_6$—259 cm^{-1}, 116 cm^{-1}, and 65 cm^{-1}; and $[(C_2H_5)_4N]_2NpCl_6$—259 cm^{-1}, 117 cm^{-1}, and 59 cm^{-1}. The Raman values are: Cs_2NpCl_6—310 cm^{-1} and 128 cm^{-1}; $[(C_2H_5)_4N]_2NpCl_6$—301 cm^{-1} and 123 cm^{-1}. The interaction constants necessary to describe the observed spectrum are the Np–Cl stretch, K; the Cl–Np–Cl bend, H; the nonbonded Cl–Cl stretch, F; the interaction, k, between two Np–Cl stretches on opposite sides of the Np atom; and an angle–angle interaction, h, between angles at right angles to each other which share a common bond. It was found that two sets of octahedral force constants calculated, using the Wilson FG matrix technique and a Urey–Bradley potential, describe the observed spectra. The Cs_2NpCl_6 spectra are described by K = 1.31 mdyne/Å, H = 0.053 mdyne/Å, F = 0.061 mdyne/Å, k = 0.40 mdyne/Å, and h = 0.015 mdyne/Å. The $[(CH_3)_4N]_2NpCl_6$ and $[(C_2H_5)_4N]_2NpCl_6$ can be described by the constants K = 1.271 mdyne/Å, H = 0.053 mdyne/Å, F = 0.05 mdyne/Å, k = 0.38 mdyne/Å, and h = 0.015 mdyne/Å. (Diss. Abstr. Int., B)

10337 MAGNETIC PROPERTIES OF Nb–Mo ALLOYS. Korsunskii, M. I.; Genkin, Ya. E.; Larin, M. P.; Milovanova, I. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 40-4 (Mar-Apr 1971). (In Russian).

The magnetic susceptibility χ of Nb–Mo alloy samples was measured over the Nb concentration range 0 to 100%, and a minimum was detected near 75% Mo. Measurements were conducted between 20 and −196°C, and a comparison with available literature data on the electronic heat capacity, was made near 1°K. The ratio γ/χ was seen to be a function of both the concentration and the temperature. (tr-auth)

10338 DEBYE FACTOR FOR NIOBIUM–ZIRCONIUM ALLOYS. Korsunskii, M. I.; Genkin, Ya. E.; Vigdorchik, L. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 73-5(Mar-Apr 1971). (In Russian).

The temperature and concentration dependence of the Debye–Waller factor was investigated in Nb–Zr alloys containing 5, 10, 15, 20, 50, and 67% Zr over the temperature interval 100 to 400°K. An irregular concentration dependence of the thermal factor was noted for compositions with 10 to 30% Zr. This was related to the phonon spectra. (tr-auth)

10339 MAGNETIC PROPERTIES OF RARE EARTH INTERMETALLIC COMPOUNDS. Kamino, Kimiyuki (Mitsubishi Steel Mfg. Co. Ltd., Tokyo). Mitsubishi Seiko Giho; 4: No. 1, 45-55(Feb 1970). (In Japanese).

Intermetallic compounds of the rare earth series are expressed by the formula of R_2Co_7, RCo_5, and R_2Co_{17}. Here R indicates Y, Ce, misch-metal cerium, or Sm, respectively. The magnetic properties of R_2Co_7 and R_2Co_{17} are insufficient for use as a practical permanent magnet, but RCo_5 and its modification, RCo_5–RCu_5, have excellent properties. Particularly, directional properties were observed in $SmCo_5$–$SmCu_5$ alloy, which was subjected to freezing in a direction normal to the cold surface of the copper hearth. The maximum energy product $(B.H)_{max}$ of 65% $SmCo_5$–35% $SmCu_5$ alloy was 5.78 MGOe in the as-cast state when it was measured in the direction perpendicular to the chill plane. The $(B.H)_{max}$ increased to 7.73 MGOe when the alloy was tempered at 300°C for 1 hour, B_r and $_BH_C$ increasing to 6,450 G and 3,400 Oe, respectively. Its magnetic properties in the direction perpendicular to the chill plane were superior to those in the other directions, and the chill plane presented a weak texture of (0001). The lattice constants of both a- and c-axes of the hexagonal crystal of $SmCo_5$–$SmCu_5$ alloy increased linearly with an increase of copper content. The axis ratio c/a was approximately 0.802 in all alloys. The results of x-ray microanalysis and x-ray diffraction suggest that the alloys of this system have a congruent point and a miscibility gap in solid solution on a quasi-binary diagram. (auth) (Japan)

10340 MAGNETIC PROPERTIES OF URANIUM BORIDES AND OF URANIUM BERYLLIDE UBe_{13}. Troc, R.; Trzebiatowski, W.; Piprek, K. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 6-7, 427-32(1971).

The magnetic susceptibilities as a function of temperature are determined for UB_2, UB_4, UB_{12}, and UBe_{13} between 4.2 and 1000°K. The interpretation of the results for the uranium borides is given in terms of the band theory. On the other hand, the 5f-localized moment on U atoms is assumed to explain the magnetic properties of UBe_{13}, the effective magnetic moment of which is found to be 3.4 μ_B. The resistivity vs temperature curve is qualitatively measured for UB_4 only. (auth)

10341 MAGNETO-ELASTIC INTERACTIONS IN TERBIUM. Jensen, Jens (Research Establishment, Risoe, Denmark). Int. J. Magn.; 1: No. 3, 271-5(May 1971).

Making use of the Hamiltonian for linear magneto-elastic coupling, proposed by Callen and Callen (1965), expressions were deduced for changes in the velocity of acoustic waves in a terbium crystal due to ferromagnetic ordering and the application of an external magnetic field. These calculations agree semiquantitatively with the results of experimental measurements. The extent to which this simple picture is applicable to explain the magnon–phonon interactions in terbium, which have been observed at finite wave vectors by inelastic neutron scattering is examined. (auth)

10342 KINETICS OF DEFECT FORMATION IN V_2O_5. Volzhenskii, D. S.; Pashkovskii, M. V. (Lvov State Univ.). Inorg. Mater (USSR) (Engl. Transl.); 7: No. 6, 871-4(Jun 1971). Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 6, 984-8(Jun 1971).

For single crystals of V_2O_5 grown under a pressure of oxygen, the variation of electrical conductivity with time at constant temperature was investigated for the three crystallographic directions. The measurements were made below the Tamman temperature so as to eliminate the influence of the external medium on the properties of the specimens. The conductivity decays according to the law $\Delta\sigma = A \exp(-t/\tau)$. The time dependence of the logarithm of the change in conductivity shows a sharp bend due to the occurrence of both forward and reverse reactions. The results are explained by means of a model in which it is assumed that formation of complexes from vacancies and interstitial oxygen atoms predominates up to 420°K, but that they dissociate on further rise of temperature. The orders and velocity constants of the forward and reverse reactions and the bond energy of the complexes, which differs in different crystallographic directions, were calculated. (auth)

10343 ELECTRICAL RESISTANCES OF Y_2O_3 AND Er_2O_3 AT HIGH TEMPERATURES. Borovkova, L. B.; Gordon, V. G.; Lukin, E. S.; (and others) (Inst. of High Temperatures, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 6, 954-5(Jun 1971). Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 6, 1074-5(Jun 1971).

The results of measurements on the temperature dependence of the electric conductivity (ρ) of monocrystalline and polycrystalline specimens of Y_2O_3, both pure and doped with Nd_2O_3, and also of single crystals of Er_2O_3 are reported. The results showed that, in contrast to Er_2O_3, the temperature dependences of electric conductivity for Y_2O_3 and Y_2O_3 + Nd_2O_3 had clearly marked maxima at 1200 and 1400°C, respectively. The linear temperature dependence of ρ for Er_2O_3 confirmed that it has no polymorphic transitions over the temperature range under investigation. Above 1200°C, the conductivity differences were gradually affected. An observed rise in conductivity for ceramic Y_2O_3 is explained by the fact that the intergrain contact resistance makes a large contribution to the conductivity of the ceramic. (P.C.H.)

10344 INTERACTIONS BETWEEN IONS WITH ORBITAL ANGULAR MOMENTUM IN INSULATORS Baker, J. M. (Monash Univ., Clayton, Australia). Rep. Progr. Phys.; 34: No. 2, 109-73(1971).

Until recently, most interest in interactions between paramagnetic ions has centered upon ions with quenched orbital angular momentum, for which exchange has the isotropic Heisenberg form $JS_1 \cdot S_2$ and the major anisotropic terms are due to magnetic dipole–dipole interaction. The interactions for ions with unquenched orbital angular momentum are quite different; exchange is anisotropic, and in addition to exchange and magnetic multipole interactions, there are sometimes sizeable anisotropic contributions from electric multipole interactions and virtual phonon exchange. The qualitative theory of these interactions has been

developed and is summarized, and the problems in making quantitative theories are discussed. A large number of experimental measurements were made, mainly on rare earth ions, but several on Co^{2+}, using electron paramagnetic resonance pair spectra and other techniques. The experimental methods and the data obtained are described. The difficulties of interpreting the mass of data are discussed, and the successful identification of particular mechanisms is critically explained. So far, the only definite example of electric multipole interaction is for Ce^{3+} ions in $LaCl_3$ and $LaBr_3$. Virtual phonon exchange is highly likely to be the principal nondipolar interaction in UO_2, rare-earth ethyl sulphates, and Pr^{3+} in $LaCl_3$. Most measured nondipolar interactions are due to exchange. (auth)

10345 INFLUENCE OF LATTICE DEFECTS ON POSITRON ANNIHILATION IN PLASTICALLY DEFORMED COPPER. Takagi, Ken-ichi; Kuribayashi, Kazuhiko; Nanao, Susumu; Tanigawa, Shoichiro; Doyama, Masao (Tokyo Univ.). Solid State Commun.; 9: No. 23, 2155-6(1 Dec 1971).

Angular correlation curves of positron annihilation in plastically deformed and annealed copper were obtained at liquid nitrogen temperature. The difference in both curves is attributed to vacancy-type lattice defects. (auth)

10346 INVESTIGATION OF PROPERTIES OF HEXAFLUORIDES OF SULFUR AND URANIUM IN A SHOCK TUBE. Dmitrievskii, V. A.; Fedulov, V. I.; Nikolaeva, V. F. Zh. Eksp. Teor. Fiz.; 61: No. 4, 1427-33(Oct 1971). (In Russian).

The pressure, density, and electric conductivity of sulfur and uranium hexalfuorides behind a shock-wave front is measured in the velocity range from 0.5 to 3.5 km/sec. A discrepancy is found between the measured density value and that calculated by the one-dimensional theory of a shock tube. This leads to an anomalous dependence of the specific heat on temperature; thus, the specific heats of the gases studied decreases with increasing temperature. The phenomenon is explained on the basis of a model of a gas consisting of "cutoff" harmonic oscillators. (auth)

10347 CAUSES OF THE ANOMALOUS TEMPERATURE DEPENDENCE OF THE CRITICAL FIELD IN TERBIUM. Belov, K. P.; Nikitin, S. A.; Murav'eva, V. M.; Solntseva, L. I.; Chuprikov, G. E. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1481-5(Oct 1971). (In Russian).

The temperature and pressure dependences of the critical field H_c in terbium were investigated, as well as thermal expansion along the c axis and magnetostriction along the c axis as functions of field strength along the easy axis in the basal plane. By comparing these data, and on the basis of the phenomenological theory previously developed for Dy, it is found that the theory yields correct order of magnitude values for dH_c/dT and dH_c/dP in terbium. The increase of the critical field strength induced by pressure and the decrease induced by cooling may be ascribed to a change in the lattice parameter c which occurs in these processes. It is shown that magnetostriction increase of the lattice parameter c on cooling results in the decrease of the critical field up to zero and in transformation of helicoidal-state structure to the ferromagnetic state. (auth)

10348 MAGNETOSTRICTION OF AN U_3P_4 SINGLE CRYSTAL. Trzebiatowski, W.; Henke, Z.; Belov, K. P.; (and others) (Inst. of Low Temperature and Structural Research, Warsaw. Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1522-5(Oct 1971). (In Russian).

Results of measurements of the magnetostriction of U_3P_4 single and polycrystals in pulsed magnetic fields are presented. It is found that the magnetostriction of the compound is large (of the order of 10^{-3} at 78°K) along the [111] crystallographic direction and is almost zero along the [100] direction. Magnetic measurements show that, in fields up to 240 kOe, the magnetization along various crystallographic directions is anisotropic. The results agree with the assumption of a noncollinear magnetic structure consisting of three sublattices directed along various directions of the [100] type being present in the compound. (auth)

10349 DYNAMICS OF CRYSTAL LATTICE OF In–Sn α-PHASE ALLOYS. Chekin, V. V.; Velikodnyi, A. I.; Plakhotin, R. O.; Rybal'chenko, L. F. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1537-44(Oct 1971). (In Russian).

The concentration dependences of the characteristic temperatures $\Theta(-1)$ and $\Theta(-2)$ corresponding to the minus first and minus second moments of the tin-impurity phonon spectrum in In–Sn α-phase alloys are investigated on the basis of the Moessbauer effect at temperatures of 77.4 and 4.2°K. The propagation velocity of 1 MHz ultrasound oscillations in polycrystalline samples of the same alloys is measured at 293, 77.4, and 20.4°K. The shear and Young moduli and also the Debye temperature are calculated. The dependences obtained show that, in the range between 1 and 2 at. % tin, the quantities mentioned above and also the linear expansion coefficient change considerably. This may be due to a transition from interacting to noninteracting impurities. According to the Moessbauer-effect data for most of the compounds, the tin atoms oscillate in the high-frequency part of the phonon spectrum; this may be manifest in the electron–phonon interaction and affect the electron properties of the alloys. (auth)

10350 ELECTRON PARAMAGNETIC RESONANCE STUDY OF GADOLINIUM HEXABORIDE. Miller, David Edward. Durham, N. C.; Duke Univ. (1971). 75p. University Microfilms Order No. 72-326.

Thesis.

The electron paramagnetic resonance spectrum of polycrystalline GdB_6 was studied at 9.16 Ghz in a reflection-type cavity spectrometer. The gadolinium ion (Gd^{3+}) was found to have isotropic g-factors and half-power linewidths of 1.9994 ± .002 and 717 Oe at 77°K, 1.992 ± .002 and 598 Oe at 194°K, and 1.991 ± .002 and 625 Oe at 293°K. From the Lorentzian shape of the resonance spectrum, it was concluded that the line is exchange-narrowed. Although there is a well-defined transition to antiferromagnetism at 16.4°K, the g-shift at 77°K is positive suggesting weak ferromagnetic exchange at this temperature. X-ray-diffraction and static susceptibility measurements were performed on the samples studied by EPR. These confirmed the existence of a single phase of cubic symmetry with $a_0 = 4.108 \pm .002$ Å. Curie–Weiss behavior with $p_{eff} = 7.98\ \mu_B$ and $\theta = 66$°K was observed above the Néel temperature of 16.4 K. (Diss. Abstr. Int., B)

10351 ADSORPTION OF LANTHANIDES ON TRANSITION METALS. Podchernyaeva, I. A.; Fomenko, V. S. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 3, 375-6(Mar 1971).

Translated from Zh. Fiz. Khim.; 45: No. 3, 680-1(Mar 1971).

The available literature data on the adsorption of lanthanides on transition metals are discussed. It has been shown that for adsorption systems with a high covalent contribution, an increase of adsorption energy with the electron work function of the adsorbent does not always occur, in consequence of the characteristics of the electronic structure of the components. (auth)

10352 MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF RARE-EARTH– AND YTTRIUM–IRON LAVES PHASES. Burzo, E. (Inst. of Atomic Physics, Bucharest). Z. Angew. Phys.; 32: No. 2, 127-32(1971).

The structural and magnetic behavior of RFe_2 (R = Gd, Tb, Dy, Ho, Er, Tm) and YFe_2 intermetallic compounds were studied. In the ordering domain, the magnetic moments of the Fe and R atoms are coupled antiparallel. The magnetic moment of iron atoms in RFe_2 compounds is approximately 1.70 μ_B, smaller compared with pure iron. In the paramagnetic region, the reciprocal susceptibility follows a Néel-type relation: $1/\chi = 1/\chi_0 + T/c = \sigma/T - \theta$, characteristic of ferrimagnetic substances. As a consequence of the thermal variation of molecular field coefficients, some corrections in the values of the Curie constants were estimated. According to the addition law of susceptibilities, the magnetic contribution of the iron atoms to the Curie constant was determined, the paramagnetic moment being $\mu_{eff} = 3.40 \pm 0.25\ \mu_B$; YFe_2 is ferromagnetic. The saturation magnetic moment of iron atoms, in this case, is $\mu_{Fe} = 1.44\ \mu_B$ while in the paramagnetic region $\mu_{eff} \approx 2.80\ \mu_B$. A decrease similar to that characteristic for the ordering domain was observed, emphasizing that the paramagnetic moments of the iron atoms are in a rather constant ratio with those of the order phase. The magnetic behavior of the iron atoms is discussed according to the model proposed by Friedel. (auth)

10353 NEUTRON DEPOLARIZATION MEASUREMENTS ON Dy NEAR THE FERROMAGNETIC TRANSITION POINT. Rauch, H.; Seidl, E.; Zeilinger, A. (Oesterreichische Hochschule, Vienna). Z. Angew. Phys.; 32: No. 2, 109-13(1971). (In German).

The antiferro–ferromagnetic transition of poly- and single-crystalline Dy samples was investigated by means of the neutron depolarization action of the ferromagnetic domains. As the polycrystalline samples showed a strong broadening of the transition temperature and very small magnetic domains, the measurements with the single crystal yielded an exact determination of the transition point as a function of temperature and magnetic field. A marked time dependence of the ferromagnetic domain structure was observed near the transition point, which demonstrates a strong magnetic after-effect and a kind of a magnetic superviscosity. (auth)

10354 MAGNETIC PROPERTIES AND MAGNETIC STRUCTURES OF Tb_3Al_2 AND Dy_3Al_2. Barbara, B.; Becle, C.; Lemaire, R. (CNRS, Grenoble, France). Z. Angew. Phys.; 32: No. 2, 113-16(1971). (In French).

The Tb_3Al_2 and Dy_3Al_2 compounds crystallize in the Hf_3Al_2 type.

Their ordering temperatures are, respectively, 190°K and 100°K. Between 190 and 10°K, Tb_3Al_2 has a ferromagnetic behavior; below this temperature, the variation of magnetization versus field is different. At 4.2 and 77°K, the magnetic structures show large ferromagnetic component parallel to the c-axis. The magnetic measurements made on a Dy_3Al_2 single crystal show a ferromagnetic behavior between 100 and 20°K. Below this temperature, the first magnetization curve no longer shows a ferromagnetic behavior. A magnetic structure showing also a large ferromagnetic component parallel to the c-axis is found at 4.3 and 47°K. The magnetic properties of Dy_3Al_2 can be explained by a new magnetization process, including narrow wall between magnetic boundaries. The conditions between exchange and anisotropy constants favoring narrow walls in the Dy_3Al_2 case are no longer performed with Tb_3Al_2 case. (auth)

10355 MAGNETIC CHARACTERISTICS OF THE MIXED-CRYSTAL SERIES $Y_2(Fe_{1-x}Co_x)_{17}$. Steiner, W.; Kirchmayr, H. R.; Springs, W. (Technische Hochschule, Vienna. Ruhr-Univ., Bochum, Ger.). Z. Angew. Phys.; 32: No. 2, 146-9(1971). (In German).

The crystallographic and magnetic characteristics of the mixed-crystal series $Y_2(Fe_{1-x}Co_x)_{17}$ are reported. At room temperature, the rhombohedral Th_2Zn_{17} structure was found for all x values. At temperatures above 1025°K, a change in the crystal structure to the hexagonal Th_2Ni_{17} type was observed, whereby the transition temperatures determined by susceptibility measurements increased with increasing Co content. A ferromagnetic coupling was found for all concentration values. The Curie temperatures increased monotonically from Y_2Fe_{17} to Y_2Co_{17}. On the iron-rich side, a maximum of the μ-x curve related to a lattice expansion due to the replacements of Fe by Co atoms was observed. The average hyperfine field acting on the iron nuclei, calculated from the Moessbauer-measurements versus the Co concentration, showed a behavior similar to the macroscopic magnetization. (auth)

10356 PARAMAGNETISM OF THE TRANSITION METALS Nb, Ta, Mo, W, AND Re AS A FUNCTION OF TEMPERATURE. Kohlhaas, R.; Wunsch, K. M. (Univ., Cologne). Z. Angew. Phys.; 32: No. 2, 158-63(1971). (In German).

An account of magnetic susceptibility measurements of the transition metals niobium, tantalum, molybdenum, tungsten, and rhenium in the temperature range from 7 to 1875°K is given. The partitioning of the magnetic susceptibility into its contributions is based on the validity of the "rigid-band" model. Particular consideration is given to the Van Vleck contribution. (auth)

10357 FERMI SURFACES AND ELECTRON SCATTERING OF DILUTE BERYLLIUM: TRANSITION METAL ALLOYS. Fiske, John Mayo. Cleveland; Case Western Reserve Univ. (1971). 111p. University Microfilms Order No. 72-33.

Thesis.

Some features of the electronic structure of beryllium single-crystal alloys containing less than 0.4 at. % copper, 0.13% nickel, or 0.014% iron are observed by means of the de Haas–van Alphen effect and residual resistivities. The magnetic-susceptibility oscillations were sensed by a torque magnetometer in fields of up to 37 kG and provide a measure of the changes of Fermi surface cross sections and cyclotron masses as well as the relaxation times associated with these orbits. A fixed-band interpretation of the observed cross sections indicates that copper subtracts one electron per atom from the conduction band, while nickel and iron subtract nearly two. The orbital relaxation time is interpreted in terms of a scattering temperature and is seen to be nearly equal for the three Fermi surface extrema observed. The solute dependence of these scattering temperatures is about the same as that observed for the residual resistivity of the alloys. These are 2.7, 9.8, and 60 μ ohm-cm per atomic percent for Cu, Ni, and Fe, respectively. A simple theoretical model is assumed to explain the scattering behavior: a square-well scattering potential accounts for the solvent–solute valence difference, and an independent resonant scattering process accounts for the presence of the virtual bound 3d states associated with these transition element impurities. The phase shifts determined by this model adequately describe the relative resistivities of copper and nickel, but fail to describe either the case of iron where resonant scattering should occur, or the relative scattering temperatures of the de Haas–van Alphen data. (Diss. Abstr. Int., B)

10358 EXTRACTION OF ISOTROPIC MULTIPLE-SCATTERING EFFECTS IN LOW-ENERGY ELECTRON DIFFRACTION WITH APPLICATION TO RHENIUM. Zimmer, Robert A. S. New Haven; Yale Univ. (1971). 310p University Microfilms Order No. 72-143.

Thesis.

An averaging method is developed for the extraction from intensity data of only multiple-scattering (M-S) effects due to the intralayer structure. The predicted reliability of the method is a maximum with one atom per unit mesh, decreasing as more atoms are added. The theoretical development makes use of the Beeby–Duke–Tucker (BDT) s-wave M-S theory of LEED. Inclusion of higher partial waves in the formalism allows demonstration that the s-wave theory can be used to predict the major intensity features due to intralayer M-S when scattering from the isolated atomic potentials comprises many partial waves of higher order. Invariance of the intralayer M-S under certain transformations of the incident-beam direction then allows interlayer M-S effects to be averaged out. Single-scattering effects, when important, can be removed with the averaging technique of Legally et al. The feasibility of the method is demonstrated by comparison of BDT s-wave calculations with LEED intensity data obtained from the basal-plane surface of hexagonal close-packed rhenium (Z = 75), and with data obtained by Baker from the same surface of hcp beryllium (Z = 4). The two metal crystals have very nearly the same atomic arrangement, but differ widely in electron-scattering cross section. BDT calculated intensities are essentially equivalent for both. Agreement with major features in the beryllium data is good. For the strongly scattering rhenium, detailed agreement is, as expected, practically nonexistent, except for the intralayer M-S effects. Twenty-six of thirty-two predicted intralayer s-wave M-S effects are observed in the energy range of 7 to 117 eV. When this result is combined with the fact that the outermost layer generally contributes about half the scattered intensity, it can be shown that the outermost layer alone can be studied by the proposed averaging method, especially when it contains only a single atomic species. Application to the analysis of long-range periodic superstructures is then of particular interest. (Diss. Abstr. Int., B)

10359 ELECTROCONDUCTIVITY OF In–Sn ALLOYS. Pashaev, B. P. Izv. Akad. Nauk SSSR, Metal.; No. 5, 86-8(Sep-Oct 1971). (In Russian).

The electric conductivities of In and of In–Sn alloys at 48, 60, 80, and 85% Sn were measured at room temperature to 600 or 700°C. The conductivity of In is a linear function of the temperature up to its melting point, and that of its alloys with Sn is nearly linear. The thermal coefficients of electrical conductivity of In and In–Sn alloys above their melting points decrease with increase in temperature. (K.S.W.)

Moessbauer Effects and NMR

Refer also to abstracts 9353, 9417, and 10051.

10360 OBSERVATION OF ^{51}V NMR IN ANTIFERROMAGNETIC STATE OF V_2O_3. Yasuoka, H. (Kyoto Univ.); Nishihara, H.; Nakamura, Y.; Remeika, J. P. Phys. Lett.; 37A: No. 4, 299-300(6 Dec 1971).

The NMR of ^{51}V in V_2O_3 was observed in the antiferromagnetic state. The hyperfine field at V atom was found to be 185.9 ± 0.1 kOe at 0°K. The quadrupolar-broadened spin-echo spectrum was interpreted as resulting from the Suhl–Nakamura interaction. (auth)

10361 ROTATING-FRAME SPIN–LATTICE RELAXATION THROUGH ANISOTROPIC CHEMICAL SHIFT IN POLYCRYSTALLINE UF_6. Blinc, R.; Lahajnar, G.; Slivnik, J. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Chem. Phys. Lett.; 11: No. 3, 344-6(15 Oct 1971).

A minimum in the temperature dependence of the ^{19}F rotating frame spin–lattice relaxation time $T_{1\rho}$ in polycrystalline UF_6 was observed that enables one to determine the correlation time for slow reorientations of the UF_6 octahedra directly. The dependence of the depth of the $T_{1\rho}$ versus temperature minimum on the external magnetic field H_0 at a fixed value of the rotating field H_1 provides an independent proof that fluctuations of the ^{19}F screening constant tensor significantly contribute to the fluorine spin–lattice relaxation rate in this system. (auth)

10362 s-BAND STATE DENSITY AT THE FERMI ENERGY IN NbN. Ehrenfreund, E.; Geballe, T. H. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 5: No. 2, 758(15 Jan 1972).

^{93}Nb spin–lattice relaxation-time measurements in NbN show that the niobium 5s contribution to the total state density at the Fermi energy is less than 10%. This result is considered in terms of electronic band models for NbN. (auth)

10363 STUDY OF CRYSTALLINE PHASES OF NbN_x AND $NbBe_x$ AND SUPPLEMENT ON ACOUSTIC NUCLEAR MAGNETIC RESONANCE. Bennett, Robert Alexander. Detroit; Wayne State Univ. (1969). 99p. University Microfilms Order No. 71-29,941.

Thesis.

Nuclear magnetic resonance (NMR) was employed to study the environment of niobium in the systems, NbN_x and $NbBe_x$. The beryllium resonance was also detected. The γ, δ, and ϵ phases of the NbN_x systems were identified by ^{93}Nb NMR spectra through an examination of six NbN_x powdered samples containing varying amounts of the phases mixed together. The crystalline environment of niobium atoms was identified by the quadrupolar broadening and splittings of the NMR lines obtained for niobium at different sites in the phases present. No appreciable Knight shifts were observed in the NbN_x samples. The quadrupole coupling constants and Knight shifts in several $NbBe_x$ compounds were obtained and employed to describe the local electronic environment at the Nb and Be sites. Multiple Nb sites in some of the $NbBe_x$ compounds are clearly identified by different quadrupole coupling constants and Knight shifts. A description of an acoustic nuclear magnetic resonance (ANMR) spectrometer is given. The ANMR of ^{127}I in KI was observed. Preparation of the single-crystal KI sample is described. (Diss. Abstr. Int., B)

Theoretical Physics

Refer also to abstracts 10412, 10479, and 10751.

10364 (IPP-4/89) ANALYTICAL SOLUTION OF A PARTIAL DIFFERENTIAL EQUATION OF THE HYPERBOLIC TYPE. Preis, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1971. 27p. (In German). Dep. NTIS (U. S. Sales Only).

An analytic solution method is given for the hyperbolic differential equation $[\partial^2T(x,t)/\partial x\partial t] + a[\partial T(x,t)/\partial x] + b[\partial T(x,t)/\partial t = 0$, with constant coefficients and the boundary conditions $T(x,o) = T_0$; $T(x,o) = T_0e^{-At}$. This is done by the Riemann integration method, which can be used to advantage for the characteristic initial-value problem, the required function $T(x,t)$ being given on the characteristics. The solution function contains an analytically unsolvable integral, which is numerically integrated by the Gauss method. The programming language used for numerical evaluation of $T(x,t)$ is Fortran IV. (auth)

10365 HAMILTONIAN SYSTEMS INVARIABLE BY THE POINCARE GROUP. Bel, Luis (Madrid Nueva Univ., Autonoma). Compt. Rend., Ser. A; 273: No. 9, 405-8(30 Aug 1971). (In French).

A new definition is proposed for Hamiltonian systems, invariable by the Poincare group in which less-restrictive conditions than the nullifying of the Poisson brackets of the position variables, are imposed. It is shown that for systems composed of only two particles, which are Hamiltonian in the sense of this definition, the system reduced to the center of mass is Lagrangian in the usual sense. (France)

10366 INTERACTION OF ACCELERATING HIGH-CURRENT ELECTRON BEAMS WITH EXTERNAL MAGNETIC FIELDS. Hammer, D. A. (Naval Research Lab., Washington, D. C.); Oliphant, W. F.; Vitkovitsky, I. M.; Fargo, V. J. Appl. Phys.; 43: No. 1, 58-60(Jan 1971).

When the current and current density of electrons accelerated in the anode–cathode gap of a field emission tube reach sufficiently high values, the induced self-magnetic field begins to dominate the electron trajectories. As a result, the spatial distribution of electrons arriving at the anode becomes strongly peaked in the center of the anode. It is possible to prevent such beam collapse with relatively modest external magnetic fields. The field is applied parallel to the electron flow (perpendicular to the anode plane). A scaling law that determines the necessary field strength, based on a simple orbit model, is found to agree with experimental results over a wide range of electron-beam parameters. (auth)

10367 STRUCTURE OF STRONG SHOCK WAVES USING THE FOKKER–PLANCK MODEL. Viswanathan, K. S.; Dwarakanath, G. S.; Shanbhag, V. V. (National Aeronautical Lab., Bangalore, India). Proc. Indian Acad. Sci., Sect. A; 74: No. 3, 115-32(Sep 1971).

The structure of strong shock waves in monatomic gases was studied using the Fokker–Planck model to represent the particle collisions and the Mott–Smith distribution to describe the distribution function within the shock front. The differential equation governing the variation of the density within the shock was derived using the variational principle. The thickness of the shock front was evaluated numerically for various monatomic gases for Mach numbers varying from 2 to 20, and the variation of the shock thickness with viscosity was also studied for different gases. Several parameters of physical interest within the shock, such as density, temperature, and mean velocity of flow were evaluated numerically and detailed curves showing their variation within the shock are presented for different Mach numbers. It was found that the temperature rises very steeply, reaches a maximum within a distance less than half the thickness of the shock and then diminishes slowly to attain its asymptotic downstream values. The variation of the mean velocity is slow for weak shocks, but for higher Mach numbers, the mean diminishes steeply and reaches the downstream values within half the thickness of the shock. (auth)

10368 APPLICATION OF A NEW COORDINATE SYSTEM FOR SOLUTION OF THE QUANTUM-SYSTEM OF THE ATOM. Dombrovski, L. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 201-10(1971). (In Russian).

The 3n coordinates of the quantum system of an atom having n electrons are expressed by 2n spherical coordinates and n radius vectors. These vectors are represented as n – 1 generalized spherical coordinates and one generalized radius vector in n-dimensional Euclidean space. This representation allows the separation of the Laplace operator, representing the sum of the radial Laplace operators of the n electrons. From this follows the factorization of the Schroedinger wave function. The types of the eigenvalues and eigenfunctions of the angular part of the Laplacian operator are known. From them and from the Schroedinger equation the eigenvalues and eigenfunctions of the radial part of the same operator are found. Next, the eigenfunctions are reduced to generalized spherical functions that are Jacobi polynomials and degenerate hypergeometrical functions. Finally, the energy eigenvalues of the unperturbed state of the quantum system are found. They show that, even in zero approximation, the collective electron motion influences the energy of the state. It is shown that the system of eigenfunctions found in the paper may not possess symmetrical properties following from the Pauli principle. The potential of the interaction between the electrons in general and in particular cases of atomic systems of practical importance is also considered. (auth)

10369 MOTION OF HIGH ENERGY PARTICLES IN A MEDIUM, IN THE DIFFUSION APPROXIMATION IN VELOCITY SPACE. Firsov, O. B. Zh. Eksp. Teor. Fiz.; 61: No. 4, 1452-62(Oct 1971). (In Russian).

The motion of a particle in a medium is described by a kinetic equation in the diffusion approximation in velocity space. The Green function is found for small angles of deviation of particle velocities from the initial direction. Thus, the distribution function with respect to scattering angle and space shifts relative to the beam axis are also found. The problem of particles "reflection" from the medium surface is reduced to two alternative integral equations, which may be solved with an electronic computer. One of the equations can be solved by the step method and the other by the iteration technique. An approximate formula for "reflection" (free term of the second integral equation) is presented that is valid for sufficiently strong slowing down of the particles and for not very small slip angles. (auth)

10370 CONVENTIONAL FORMULATIONS OF NOETHER'S THEOREM IN CLASSICAL FIELD THEORY. Rosen, Joe (Tel-Aviv Univ., Israel). Int. J. Theor. Phys.; 4: No. 4, 287-94 (Aug 1971).

The role of invariance considerations in conventional formulations of Noether's theorem in classical field theory is investigated and found weaker than is usually supposed. It is shown how nonfulfilment of the conventional assumptions going into Noether's theorem brings about nonconservation. (auth)

10371 HAMILTON–JACOBI FUNCTIONAL THEORY FOR INTEGRATION OF CLASSICAL FIELD EQUATIONS. Rosen, Gerald (Drexel Univ., Philadelphia). Int. J. Theor. Phys.; 4: No. 4, 281-5(Aug 1971).

By employing the terminology of functional differential calculus, Hamilton–Jacobi theory is extended to apply to classical field equations. It is shown that an asymptotic solution to the Hamilton–Jacobi functional differential equation provides an asymptotic general solution to the associated nonlinear classical field equations. (auth)

10372 QUANTUM KINEMATICS OF FERMI–DIRAC VACUUM-PLUS-ONE-ELECTRON PROBLEM. Kumar, N. (Indian Inst. of Science, Bangalore). Proc. Indian Acad. Sci., Sect. A; 74: No. 2, 79-82(Aug 1971).

Following Weisskopf, the kinematics of quantum mechanics is shown to lead to a modified charge distribution for a test electron embedded in the Fermi–Dirac vacuum with interesting consequences. (auth)

10373 NUMERICAL CALCULATION OF MAGNETIC FIELDS IN THE VICINITY OF A MAGNETIC BODY. Ruehli, A. E. (IBM Components Lab., Burlington, Vt.); Ellis, D. M. IBM J. Res. Develop.; 15: No. 6, 478-82(Nov 1971).

Static magnetic fields, resulting from an applied field, are calculated in the vicinity of a magnetic body. Specifically, numerical results are given for a rectangular body of constant permeability. The reduction or shielding of the magnetic fields is calculated in the neighborhood of the body. Integral equations are developed that can be solved numerically on a computer. Typical fields are described for rectangles of different thicknesses, and comparisons with known solutions are shown. (auth)

10374 MOTION OF A CHARGED PARTICLE IN A UNIFORM ELECTRIC FIELD WITH RADIATION REACTION. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Int. J. Theor. Phys.; 4: No. 3, 179-84(May 1971).

It is shown that the motion of a charged particle in a uniform electric field, obeying the Dirac–Lorentz relativistic equation of motion with radiation reaction, is confined in a plane. Further, the component of velocity normal to the lines of force continuously decreases to zero. Thus, the motion asymptotically tends to a rectilinear motion along the line of force. The motion is completely described up to a correcting factor $1 + 0\,[(e^3F/m^2c^4)^2]$; $e^3F/m^2c^4 \simeq 5 \times 10^{-14}$ F for electrons, F in the volts cm^{-1}. (auth)

10375 DYNAMICS OF PROBABILITY DISTRIBUTIONS OVER CLASSICAL FIELDS. Rosen, Gerald (Drexel Univ., Philadelphia). Int. J. Theor. Phys.; 4: No. 3, 189-95(May 1971).

It is shown that the original Hopf formulation for the time evolution of probability distributions over classical fields follows deductively from the space–time version of the theory. (auth)

10376 DECISION PROBLEM FOR MATHEMATICAL STRUCTURES OF QUANTUM THEORY. Benedetti, A.; Teppati, G. (Univ., Lecce, Italy). Lett. Nuovo Cim.; 2: No. 14, 695-6 (2 Oct 1971).

Some results concerning the decision problem relative to a well-known mathematical structure of quantum mechanics are enunciated. (J.F.P.)

10377 SOLUTION OF THE SCHROEDINGER EQUATION IN TERMS OF WAVE FUNCTIONS LEAST DISTORTED FROM PRODUCTS OF ATOMIC WAVE FUNCTIONS. Adams, W. H. (Technische Univ., Munich. Rutgers–The State Univ., New Brunswick, N. J.). Chem. Phys. Lett.; 11: No. 4, 441-4(1 Nov 1971).

An effective N-electron hamiltonian for wave functions that are least distorted from products of atomic wave functions is derived. An eigenfunction of this hamiltonian under symmetry projections yields one or more exact solutions to the Schroedinger equation. An approximate eigenfunction yields one or more approximate solutions to the Schroedinger equation. The more accurate an approximate eigenfunction of this hamiltonian is, the more accurate are the approximate solutions to the Schroedinger equation that can be obtained from it. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

10378 (ORO–3509-8) ELEMENTARY PARTICLE PHYSICS AT THE FLORIDA STATE UNIVERSITY. Progress Report, November 1, 1970–October 31, 1971. [Lannutti, J. E.] (Florida State Univ., Tallahassee. Dept. of Physics). Oct 1971. Contract AT(40-1)-3509. 16p. Dep. NTIS.

Theoretical and experimental research on elementary particle interactions is summarized. A list of publications is included. (J.F.P.)

10379 SEARCH FOR QUARKS USING A FLASH TUBE CHAMBER. Ashton, F.; Coats, R. B.; King, J.; Tsuji, K.; Wolfendale, A. W. (Univ. of Durham, Eng.). J. Phys., A (London); 4: No. 6, 895-907(Nov 1971).

A large flash tube chamber was constructed with the object of searching for relativistic e/3 quarks in extensive air showers (EAS) at ground level. Experiments were carried out to examine the applicability of the method; in particular, the response of the apparatus to muons of varying ionization was investigated. It was found that the logarithmic increase in ionization loss is reflected accurately in the variation of mean flash-tube efficiency with muon energy, which gives confidence in the method. Furthermore, the fluctuation in number of flashed tubes along a muon track is close to expectation. In a preliminary search no e/3 quarks were detected amongst 439 carefully measured penetrating EAS particles, and already there is an inconsistency with the data of McCusker and Cairns. [Phys. Rev. Lett.; 23: 658-9(1969)] (auth)

Electromagnetic

Refer also to abstracts 10562 and 10683.

10380 (CONF-710637–3) DEEP INELASTIC ELECTRON SCATTERING: EXPERIMENTAL. Friedman, Jerome I. (Massachusetts Inst. of Tech., Cambridge). Oct 1971. Contract AT(30-1)-2098. 38p. (IC–71/136). Dep. NTIS.

From Seminar on electromagnetic interactions; Trieste, Italy (21 Jun 1971).

A review is given of experimental information on high-energy inelastic electron–proton scattering considering particularly the cross sections and structure functions. The inelastic electron–neutron scattering cross sections are also discussed. (J.F.P.)

10381 (KHFTI–70-36) INTERFERENCE EXPERIMENT WITH SYNCHROTRON RADIATION PHOTONS OF ELECTRONS IN A STORAGE RING. Grishaev, I. A.; Guk, I. S.; Mazmanishvili, A. S.; Mocheshnikov, N. I.; Reprintsev, L. V.; Tarasenko, A. S.; Shenderovich, A. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

In experiments on the interference properties of photons, it was shown that photons of synchronous emission of five and more electrons in a storage ring form an interference pattern in Zhamen's interferometer. Photons of synchronous emission are distributed statistically independently, with an average flux of 2,500 photons/sec. With this intensity and a Poisson distribution of photons, there is practically eliminated the appearance of two photons in the interferometer. The visibility of a null interference maximum with respect to the first interference minimum in the region of linearity of film is constant and is in agreement with the theoretically calculated values. (K.S.W.)

10382 HIGH-ENERGY PHYSICS WITH THE ORSAY e^+–e^- STORAGE RING. Haissinski, J. (Faculte des Sciences, Orsay, France). Rend. Scu. Int. Fis. Enrico Fermi; 46: 156-83(1971).

The study of leptonic final states and hadronic final states with the Orsay e^+–e^- storage ring is described. Normalization of cross section measurements, quantum electrodynamics, and strongly interacting final states are discussed. A description of the experiments is given and the results are compared with vector meson dominance model predictions. (L.B.S.)

10383 HIGH-ENERGY π^0 PHOTOPRODUCTION FROM HYDROGEN WITH UNPOLARIZED AND LINEARLY POLARIZED PHOTONS. Anderson, R. L. (Stanford Linear Accelerator Center, Calif.); Gustavson, D. B.; Johnson, J. R.; (and others). Phys. Rev., D; 4: No. 7, 1937-46(1 Oct 1971).

Measurements were made of the differential cross section for $\gamma + p \rightarrow \pi^0 + p$, and the asymmetry with polarized photons, for incident photon energies from 4 to 18 GeV and momentum transfers between $t = -0.1$ and -1.4 $(GeV/c)^2$. The experiment was performed at the Stanford Linear Accelerator Center, using the SLAC 1.6-GeV/c spectrometer to analyze protons recoiling from a hydrogen target. For the cross-section measurements a normal collimated bremsstrahlung beam was used. For the asymmetry measurements the polarized photons were produced by coherent bremsstrahlung from a diamond crystal, and a coincidence was required between the recoil proton and one of the π^0 decay photons in a shower counter. (auth)

10384 OPTICAL PHOTONS IN COINCIDENCE WITH β PARTICLES. der Mateosian, E.; Thieberger, P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 27: No. 26, 1816-19(27 Dec 1971).

Photons in the visible region, detected in coincidence with β rays from a $^{90}Sr-^{90}Y$ source, have been shown to be internal bremsstrahlung containing a small admixture of transition radiation. (auth)

10385 MAGNETIC MOMENT OF THE PROTON IN BOHR MAGNETONS. Winkler, P. Frank; Kleppner, Daniel; Mynit, Than; Walther, Frederick G. (Massachusetts Inst. of Tech., Cambridge, Mass.). Phys. Rev., A; 5: No. 1, 83-114(Jan 1972).

The magnetic moment of the proton was measured by observing simultaneously an electronic and a nuclear magnetic transition in atomic hydrogen. Observations were made with a hydrogen maser operating in a 3500-G field. A theory is presented for the transient response of a three-level system under conditions of double resonance including effects of cavity pulling, spin-exchange collisions, and frequency shifts due to motional field narrowing. The electron-proton g-factor ratio in hydrogen is found to be $g_j(H)/g_p(H) = \mu_j(H)/\mu_p(H) = -658.210,706(6)$. This leads to a value of the proton moment in Bohr magnetons of $\mu_p/\mu_B = 1.521,032,181\ (15) \times 10^{-3}$. (auth)

10386 PRECISION MEASUREMENT OF THE g FACTOR OF THE FREE POSITRON. Gilleland, John R.; Rich, Arthur (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 5: No. 1, 38-49(Jan 1972).

A precision measurement of the g factor of the free positron is described. The basic experimental technique is that developed by Rich and Crane in an earlier positron experiment: A group of positrons from a ^{58}Co source is confined in a magnetic mirror trap. On emission from the source, the positron beam is polarized parallel to its average velocity $\langle\vec{v}\rangle$, with polarization $\vec{P} = \langle\vec{v}\rangle/c$. While in the field the beam undergoes cyclotron orbital motion at an angular frequency ω_c. Simultaneously $\vec{P}$ precesses at an angular frequency ω_s, i.e., $\vec{P}$ rotates about $\vec{v}$ at the difference frequency $\omega_D = \omega_s - w_c$. After a controlled length of time, the particles are ejected from the trap and sent into a polarimeter, this being a device whose response is proportional to the helicity, $\vec{v} \cdot \vec{P}/|\vec{v}||\vec{P}|$. The recorded polarimeter output vs trapping time is fitted to a cosine curve and the best-fit frequency is taken as ω_D. This measurement of ω_D, when combined with a measurement of the time-averaged field B experienced by the positrons in the trap, is the basis of the experiment. More explicitly, if the g factor is written as $g = 2(1 + a)$, where a is the g factor anomaly, then $a = (m_0c/eB)\omega_D$. The principal difference between the present experiment and previous work is the use of a pulsed coil instead of a dc magnet to generate a 10-kG magnetic field used in the polarimeter. Fringe fields from the dc magnet caused severe drifting of the trapped beam, a problem which has been overcome by use of the coil. The longer trapping times now obtained account for a factor of 5 improvement in measurement accuracy. The result of the experiment may be written as $a = (11,603 \pm 12) \times 10^{-7}$. Invariance under TCP requires equality of the electron and positron g factors. The results, when compared with previous electron measurements, serve to confirm this prediction at the 1-ppM level in the g factor. Furthermore, since the μ^+ and μ^- g factors are equal to within 0.7 ppM, any violation of TCP which manifests itself in a lepton-antilepton g factor asymmetry is ruled out at the 1-ppM level. (auth)

10387 PHOTOPRODUCTION AND FORBIDDEN DECAYS OF φ MESONS. Alvenselben, H.; Becker, U.; Biggs, P.; (and others) (Massachusetts Inst. of Tech., Cambridge. Deutsches Elektronen Synchrotron, Hamburg). Phys. Rev. Lett.; 28: No. 1, 66-9(3 Jan 1972).

Photoproduction of φ mesons from hydrogen and carbon was studied at 5.2 GeV by observing $\varphi \rightarrow K^+K^-$ decays. The results show that φ's are produced diffractively with a φ-nucleon cross

section $\sigma_{\varphi N} = 9.8^{+3}_{-1.5}$ mb. In addition, 80,000 pion pairs were measured to search for the G-parity–nonconserving decay $\varphi \rightarrow \pi^+\pi^-$. If complete interference between $\rho \rightarrow \pi^+\pi^-$ and $\varphi \rightarrow \pi^+\pi^-$ is assumed, an upper limit of $\Gamma_{\varphi\rightarrow 2\pi}/\Gamma_{\varphi\rightarrow all} = 2.7 \times 10^{-4}$ is found at the 95% level. (auth)

10388 MEASUREMENT OF THE BRANCHING RATIO $\gamma(K_L \rightarrow 2\gamma)/\gamma(K_L \rightarrow 3\pi^0)$. Barmin, V. V.; Barylov, V. G.; Veselovskii, G. S.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 5, 986-8(Nov 1971). (In Russian).

By means of the 180-l xenon bubble chamber of ITEP the ratio $\Gamma(K_L \rightarrow 2\gamma)/\Gamma(K_L \rightarrow 3\pi^0)$ was measured. The result is $(2.13 \pm 0.43) \cdot 10^{-3}$. (auth)

Weak

10389 POSSIBLE MACROEXPERIMENT WITH A LONGITUDINAL NEUTRINO. Fakirov, D. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 149-51(1971). (In Bulgarian).

An effect of rotation completely determined by the longitudiness of the neutrino is discussed. The experiment resembles that of Einstein and de Haas and consists in rotation of the radioactive backing emitting beta-particles and the neutrino. (auth)

10390 K_{e3} CHARGE ASYMMETRY. Shields, Dennis John. San Diego, Calif.; Univ. of California (1971). 141p. University Microfilms Order No. 71-24,130.

Thesis.

The charge asymmetry was measured in K_{e3} decays using a wire spark chamber spectrometer. The resulting asymmetry, $\delta = (N_+ - N_-)\ (N_+ + N_-)$ where the ± subscript refers to the sign of the outgoing charged lepton in the decay process ($K_2 \rightarrow \pi^-e^+\nu$ or $K_2 \rightarrow \pi^+e^-\nu^-$), is $(3.6 \pm 1.8) \times 10^{-3}$ based on approximately 750,000 events. The positron decay mode is favored. This nonzero result shows the nonorthogonality of the states K_1 and K_2 and is direct evidence of CP violation in the neutral K meson system. The relation between the charge asymmetry and the other parameters specifying CP violation in the K system is also examined. (Diss. Abstr. Int., B)

10391 RESULTS ON THE $\Delta S = \Delta Q$ RULE FROM K_{e3}^0 AND $K_{\mu 3}^0$ DECAYS. Burgun, G. (CEN, Saclay, France); Lesquoy, E.; Muller, A.; (and others). Lett. Nuovo Cim.; 2: No. 23, 1169-73 (4 Dec 1971).

The time distribution of semi-leptonic decays of the neutral K-meson was studied from the reaction $K^+p \rightarrow K^0p\pi^+$ at 1.4 and 1.7 GeV/c in a hydrogen bubble chamber. 167 $\pi e\nu$ decays and 40 $\pi\mu\nu$ decays of known lepton charge were identified. The results were found compatible with no violation of the $\Delta S = \Delta Q$ rule. Values were obtained for the ratio of the $\Delta S = -\Delta Q$ amplitude to the $\Delta S = \Delta Q$ amplitude for K_{e3} and $K_{\mu 3}$ decays. (L.B.S.)

10392 ANALYSIS OF THE PION SPECTRUM OF 39 819 τ^+ DECAYS AT REST. Hoffmaster, S. (Stevens Inst., of Tech., Hoboken, N. J.); Koller, E. L.; Taylor, S.; (and others). Nucl. Phys.; B36: No. 1, 1-10(1972).

The energy spectrum of the secondary pions of 39 819 τ^+ decays at rest was examined. It was found to be adequately fitted by the linear form $|M|^2 \propto 1 + \alpha_{\tau+}(M_K Q/m_\pi^2)$ Y, $\alpha_{\tau+} = 0.134 \pm 0.005$. The value of the slope parameter is in good agreement with other τ^+ experiments and in fair agreement with theoretical predictions. If one assumes a linear squared matrix element, the $\Delta I = 1/2$ rule was found to be significantly violated for charged $K^+ \rightarrow 3\pi$ decays. (auth)

Strong (Baryon-Induced)

10393 (INR-P-1329) FURTHER EXPERIMENTAL TESTS OF SCALING IN THE PROCESS $pp \rightarrow \pi^- +$ ANYTHING. Michejda, Lech (Institute of Nuclear Research, Warsaw (Poland)). 1971. 57p. Dep. NTIS (U.S. Sales Only).

The hypothesis of scaling in the c.m. longitudinal momentum for the single-particle distribution of pions is checked against various experimental data on inelastic pp reactions. The so-called structure function fitted by Bøggild, Hansen and Suk for the π^- produced in the process $pp \rightarrow \pi^- +$ anything at 19 GeV/c was used as an input. Its consequences for the prong multiplicity, the average transverse momentum and angular distributions for various energies, including both the accelerator and the cosmic ray data are discussed. Crucial tests of the predicted infinitely developing peak at $P_L = 0$ for the scaled longitudinal momentum distribution $d\bar{\sigma}/dx$ are discussed. Some evidence that narrowing of this peak with increasing energy is faster than expected from scaling is presented. (auth)

10394 (ITEF–758) PERIPHERAL PARTICLE GENERATION AT HIGH ENERGY. Kolkunov, V. A.; Nikolaevskii, E. S.; Ter-Martirosyan, K. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The π^-, K^-, $\bar{p}$ spectra obtained by the Serpukhov-CERN group are naturally reproduced by the peripheral generation model (the incident proton energy is 70 GeV). The fast decrease of spectra with energy is due to the decrease of the vertex of proton transformation into the system of final particles. The vertices of such type are important in the high energy physics as they determine the cut contribution to the interaction total cross section. (auth)

10395 (LUIP-CR-71-5) INTERACTIONS BETWEEN NUCLEI AT 100 TO 500 MeV/NUCLEON. Resman, R.; Otterlund, I. (Lund Univ. (Sweden). Dept. of Physics). Sep 1971. 30p. Dep. NTIS (U. S. Sales Only).

Nucleus-nucleus interactions produced by heavy cosmic ray primaries in nuclear emulsions were analyzed. The kinetic energy of the incident nuclei is 100 to 500 MeV/nucleon. Whenever possible the particles leaving the point of interaction were identified and their emission angles and kinetic energies measured. The angular and energy distribution of the protons emitted can be understood if reasonable values of the momenta of the interacting nucleons inside the colliding nuclei are considered, and if it is further assumed that interactions between nucleons and clusters of nucleons occur. The momentum distribution of the emitted protons and alpha-particles is consistent with an average recoil momentum of the target nuclei of about 23 MeV/c per nucleon. It is found that about 30% of the particles with ranges in the interval $10\ \mu m < R \leq 100\ \mu m$ cannot be explained by ordinary evaporation theory. The spallation of the target and the projectile was studied. It was found that the disintegration of the two interacting nuclei increases with increasing projectile energy. (auth) (Sweden)

10396 DISPERSION ENERGY RELATION FOR ULTRA-HIGH ENERGY NUCLEAR REACTIONS IN EMULSION. Curran, A. J. (Dublin Inst. for Advanced Studies). J. Phys., A (London): 4: No. 6, 888-94(Nov 1971).

When a large volume of data from cosmic ray emulsion reactions is analyzed it is found that the variation of the mean dispersion s in the log tan theta plot of the charged secondaries, at each energy, follows a linear characteristic when plotted against the log energy of the incident particle. The slope of the characteristic is peculiar to the type of incident particle, and is higher for nucleon–nucleon collisions than for pion–nucleon events. (auth)

10397 PION PRODUCTION IN PROTON–BERYLLIUM COLLISIONS AT 12.4 GeV/c. Cho, Y. (Argonne National Lab., Ill.); Derrick, M.; Marmer, G.; (and others). Phys. Rev., D; 4: No. 7, 1967-74(1 Oct 1971).

The absolute cross sections for π^+- and π^--meson production in proton-beryllium collisions at 12.4 GeV/c are reported. Measurements were made for laboratory production angles between 0 and 12° and pion momenta between 2 and 6 GeV/c. All recent data for pion production in p-Be collisions are fitted with an empirical relation first suggested by Sanford and Wang. (auth)

10398 $\bar{p}p$ ANNIHILATIONS AT REST INTO $\eta\pi^+\pi^-$. Espigat, P.; Ghesquiere, C.; Lillestoel, E.; Montanet, L. (CERN, Geneva). Nucl. Phys.; B36: No. 1, 93-8(1972).

The properties of the three-body annihilations at rest $\bar{p}p \rightarrow \eta^0\pi^+\pi^-$ are analyzed using the final-state interaction model. The $A_2 \rightarrow \eta\pi^+$ decay is compared to other decay modes observed in $\bar{p}p$ annihilations at rest. (auth)

10399 INVESTIGATION OF REACTION $pp \rightarrow \pi^+np$ AT THE ENERGY OF 650 MeV. Zul'karneev, R. Ya.; Medved, S. V.; Nadezhdin, V. S.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 5, 989-93(Nov 1971). (In Russian).

Differential cross sections $d^3\sigma/dT_\pi^L d\Omega_\pi d\Omega_p^L$ for the reaction $pp \rightarrow \pi^+np$ at the energy of 650 MeV are measured by means of a set-up consisting of H_2 target, a system of scintillation counters and the acoustic spark chamber operating on line with the Minsk-22 computer. The obtained experimental results are compared with the peripheral one-pion exchange model by Selleri. (auth)

10400 TOTAL CROSS SECTIONS OF INTERACTIONS OF π^+, K^+ MESONS, AND PROTONS WITH PROTONS AND DEUTERONS IN THE MOMENTUM RANGE 15 TO 60 GeV/c. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 14: No. 5, 998-1005(Nov 1971). (In Russian).

Results of measurements of the total cross sections for inter-

actions of positive pions, kaons and protons with protons and deuterons in the momentum range 15 to 60 GeV/c are presented. (auth)

Strong (Meson-Induced)

10401 (INP–761) ON THE ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN π^--p INTERACTIONS AT 60 GeV. Furmanska, B.; Gierula, J.; Holynski, R.; Krzywdzinski, S.; Linscheid, A. (Institute of Nuclear Physics, Krakow (Poland)). Jun 1971. 29p. Dep. NTIS (U. S. Sales Only).

The asymmetry of the angular distribution of secondary particles in 60-GeV π^--p interactions is investigated. In particular, the influence of the use of the ultrarelativistic transformation on the obtained value of the asymmetry parameters of angular distribution is estimated. The angular distributions of secondary particles in π^--p interactions with primary energies 16 and 60 GeV are compared. A simple approximate method of transformation of the angular distribution from the Lab-system to the CM-system in the case of unknown masses and energies of produced particles is presented. (auth)

10402 (NP-19138) $X^0(960)$: PRODUCTION IN THE REACTION π^-p AND DISINTEGRATION IN $\pi^+\pi^-\eta$. Dufey, Jean-Pierre (European Organization for Nuclear Research, Geneva (Switzerland)). 1970. 51p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Eidgenoessische Technische Hochschule, Zurich (Switzerland).

The production cross sections for $X^0(960)$ in the reaction $\pi^- + p \rightarrow X^0 + n$ at 1.50 and 1.52 GeV/c are determined. Also the decay $X^0 \rightarrow \pi^+ + \pi^- + \eta$ is studied. The angular distribution and the X^0 (quantum numbers) are discussed. (J.F.P.)

10403 (UCRL–20644) K^+D INTERACTIONS AT 12 GeV/c. Lissauer, David A. (California Univ., Berkeley. Lawrence Radiation Lab.). 20 May 1971. Contract W-7405-eng-48. 157p. Dep. NTIS.

Thesis.

The following reactions were studied in a deuterium-filled bubble chamber exposed to a 12-GeV/c K^+ meson beam: $K^+n \rightarrow K^0p$, 163 events; $K^+n \rightarrow K^+\pi^-p$, 6454 events; $K^+n \rightarrow K^0\pi^+\pi^-p$, 865 events; $K^+d \rightarrow K^+\pi^+\pi^-d$, 5834 events; and $K^+d \rightarrow K^0\pi^+d$, 133 events. The differential cross section for the charge exchange reaction $K^+n \rightarrow K^0p$ was measured and it was found that the forward amplitude is mainly real, the differential cross section equals that for the $K^-p \rightarrow \bar{K}^0n$ charge exchange reaction, and the differential cross section agrees well with the prediction of the Regge pole model of Rarita and Schwarzchild. The reaction $K^+n \rightarrow K^+\pi^-p$ was found to be dominated by $K^*(890)$, $K^*(1420)$ production. Evidence is presented for the existence of: a possible enhancement at $M(K\pi) \approx 1250$ MeV with an angular distribution consistent with a spin parity $J^P = 0^+$ or 1^-; $K^*(1380)$ resonance with $M \approx 1380$ MeV, $\Gamma < 150$ MeV, with spin parity 0^+ if produced by pion exchange, but $J^P = 1^-$ or 2^+ cannot be ruled out; structure in the K^+, π^- system at a mass near 1.85 GeV. One interpretation of the observation is the production by pion exchange of a $J^P = 3^-K^*$ resonance at about this mass, which interferes strongly with other processes. The coherent reaction $K^+d \rightarrow K^+\pi^+\pi^-d$ is dominated by Q^+ production. Evidence for structure in the Q^+ region is presented. Assuming two resonances are present, the result can be interpreted as the mixing of two $J^P = 1^+K^*$ states. Also D^{*++} and L produced were studied in the same final state. The reaction $K^+d \rightarrow K^0\pi^+d$ is dominated by $K^*(890)$ produced by vector exchange. (auth)

10404 VAN HOVE ANALYSIS OF THE REACTIONS $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ AND $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$ AT 16 GeV/c. Ballam, J.; Chadwick, G. B.; Guiragossian, Z. G. T.; (and others) (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 7, 1946-67(1 Oct 1971).

Data from the reactions $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ and $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$ were obtained at 16 GeV/c in approximately equal samples from the BNL 80-in. hydrogen bubble chamber. Both reactions were studied for resonance production and the results were compared with predictions of the one-pion-exchange model (OPEM) calculated by Wolf. The four-body longitudinal phase-space (LPS) plot suggested by Van Hove was used to analyze the data from both reactions. The events were separated according to distinct regions of the LPS plot in order to study the following classes of quasi-two-body final states: (1) diffractively produced three-pion states, (2) diffractively produced $\pi\pi p$ states, (3) double-resonance production such as $\rho^0\Delta^{++}$, (4) single-resonance production such as $\pi^-\pi^-\Delta^{++}$. The Van Hove analysis provided a much cleaner separation of resonances from background effects than the usual techniques. Production of the A_1 and A_2 mesons as well as the $N^*(1470)$ and $N^*(1700)$ isobars was observed in the $\pi^+\pi^-p$ system for both reactions. There is strong formation of the doubly resonant states $\rho^0\Delta^{++}$ and $f^0\Delta^{++}$ and the general features of the nondiffractive events are all in good agreement with one-pion exchange. Detailed comparisons between the data and the OPEM in each LPS plot region show that Van Hove analysis provides a sensitive test for the OPE model. (auth)

10405 $K^*(890)$ PRODUCTION IN THE CHARGE-EXCHANGE REACTION $K^+n \rightarrow K^+\pi^-p$ AT 9 GeV/c. Cords, D. (Purdue Univ., Lafayette, Ind.); Carmony, D. D.; Clopp, H. W.; (and others). Phys. Rev., D; 4: No. 7, 1974-8(1 Oct 1971).

The energy dependence of the cross section for reactions $K^+n \rightarrow K^*(890)p$ and $K^-p \rightarrow K^*(890)n$ is compared over a wide range of incident momenta and found to be identical. This excludes odd C-parity exchanges in addition to the dominant π exchange. The conventional absorption model does not reproduce the rapid decrease of ρ_{00} as a function of the four-momentum transfer. The Reggeized π-A_2 model of Dass and Froggatt reproduces the t dependence of ρ_{00} and $\mathrm{Re}\rho_{10}$, but there is serious disagreement for ρ_{1-1} which may indicate the need to include A_1 exchange. The asymmetry in the decay angular distribution is interpreted as S-P wave interference. (auth)

10406 MEASUREMENT OF THE Λ MAGNETIC MOMENT. Hill, D. A. (Massachusetts Inst. of Tech., Cambridge); Li, K. K.; Jenkins, E. W.; Kycia, T. F.; Ruderman, H. Phys. Rev., D; 4: No. 7, 1979-96(1 Oct 1971).

The magnetic moment of the Λ hyperon was measured at the Brookhaven cosmotron. Polarized Λ hyperons were produced by (1.02 ± 0.015)-GeV/c π^+ mesons incident on a Be target in the reaction $\pi^+ + n \rightarrow K^+ + \Lambda$. After passing through a strong pulsed longitudinal magnetic field, the Λ decay and the K^+ were observed in parallel-plate spark chambers in which the decay proton and/or the decay π^- could stop to facilitate momentum measurement. The spark chamber was triggered by an electronic counter system where the K^+ mesons were identified by velocity, specific ionization, and decay. The precession of the Λ polarization was detected by observing the rotation of its asymmetric decay distribution projected onto a plane perpendicular to the Λ trajectory. Measurement of the direction and magnitude of the angle of rotation about the magnetic field direction gave the moment and its sign. Based on 3868 field-on events with an average value of the ratio $\int \vec{H} \cdot \vec{dl}/p_\Lambda$ of about 800 kG cm/(GeV/c), the magnetic moment of the Λ hyperon was found to be −0.73 ± 0.18 nuclear magneton. (auth)

10407 OBSERVATION OF ENERGY-DEPENDENT STRUCTURE IN BACKWARD π^-d ELASTIC SCATTERING BETWEEN 496 AND 1050 MeV/c. Schroeder, L. S. (Iowa State Univ., Ames); Crabb, D. G.; Keller, R.; (and others). Phys. Rev. Lett.; 27: No. 26, 1813-16(27 Dec 1971).

Differential cross sections for backward π^-d elastic scattering were measured from 496 to 1050 MeV/c. The differential cross sections are generally smooth and consistent with the presence of low partial waves. An enhancement in the 180° cross section is observed near 700 MeV/c, with indications of a similar effect near 900 MeV/c. This structure is discussed in terms of an I = 1, B = 2 state of an N*N effect associated with the deuteron. (auth)

10408 STUDY OF THE REACTION $\pi^-p \rightarrow \pi^\pm N^{*\mp}_{1236}$ NEAR 180° FROM 2.15 TO 6.0 GeV/c. Rice, James Eugene. Ann Arbor, Mich.; Univ. of Michigan. (1970). 173p. University Microfilms Order No. 71-23,857.

Thesis.

The execution, analysis, and the results of a missing mass optical spark chamber experiment which investigated the general features of the reaction $\pi^-p \rightarrow \pi^\pm$ (anything) near 180° are described. Data were taken at 11 beam momenta from 2.15 to 6.0 GeV/c and later combined into four beam momentum ranges. In order to study possible N* resonance production, missing mass plots were made. These missing mass plots show little structure except in the N^{*+}_{1236} region. The N^{*++}_{1236} cross section is consistent with being zero everywhere in this energy range. The N^{*-}_{1236} cross section exhibits a sharp dip at 180° in each of the four beam momentum ranges. This dip seems to be a result of strong production of the helicity 3/2 state for the N*. The cross section for N^{*-}_{1236} production is inconsistent with the quark model prediction of Bialas et al. (Diss. Abstr. Int., B)

10409 K^+p CROSSING SECTIONS BETWEEN 2.1 AND 2.7 GeV/c. Brunet, J. M. (Coll. de France, Paris); Narjoux, J. L.; Danysz, J. A.; (and others). Nucl. Phys.; B36: No. 1, 45-57 (1972).

Cross sections are presented for the K^+p interactions with 2, 3, 4 and 5 particles in the final state for incident momenta between 2.1 and 2.7 GeV/c. The results are compared with those from other experiments at nearby momenta. (auth)

10410 SEARCH FOR BARYON RESONANCES IN THE pγ SYSTEM. Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 6, 243-5(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6, 363-5(20 Sep 1971).

The results of a search for baryon resonances in the mass interval $M_n 2N^* < M_B + M_\pi$ and decaying according to the scheme $N^* \rightarrow p + \gamma$ are presented. The reactions of 5-GeV/c π^- in a propane bubble chamber were used. At 90% confidence level the upper limit of the cross section is found for the production of this resonance in the reaction $\pi^- + p \rightarrow \pi^- + m\pi^0 + N^*$, $N^* \rightarrow p + \gamma$ is 70 μb. (J.F.P.)

10411 SPLITTING OF THE A_2 MESON. Kaidalov, A. B. JETP Lett. (USSR) (Engl. Transl.); 14: No. 6, 262-4(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6, 387-91(20 Sep 1971).

It is pointed out that the available experimental data for A_2 splitting can be explained if it is assumed that there exists a strong destructive interference between the A_2 resonance and the background. The interactions $\pi^+ + p \rightarrow \rho^0 + \pi^+ + p$, $\pi^- + p \rightarrow \rho^0 + \pi^- + p$, $\pi^- + p \rightarrow \rho^+(\rho^-) + \pi^-(\pi^+) + n$, and $\pi^- + p \rightarrow K^+ + K^- + n$ are considered. (J.F.P.)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 10754.

General

Refer also to abstract 10378.

10412 (ORO-3992-73) STATISTICAL MECHANICS OF PARAFERMI SYSTEMS. Richard, J. L.; Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). 29 Nov 1971. 25p. (CPT-126). Dep. NTIS.

The statistical mechanics of a collection of parafermi harmonic oscillators considered as a canonical ensemble is examined. The factorization property of the corresponding partition function selects the representations of the parafermi ring allowed to furnish the energy levels of the oscillators. While the representations corresponding to Green's ansatz are in an obvious way perfect candidates, it is shown however that, contrary to expectations, they do not exhaust all the possibilities. The general conditions on the representations are given and special families of representations are outlined. (auth)

10413 CURRENT ALGEBRA SUM RULES FOR CROSS-SECTIONS OF INCLUSIVE EXPERIMENT. Shei, Sun-sheng; Suzuki, M. (Univ. of California, Berkeley). Lett. Nuovo Cim.; 2: No. 22, 1127-30(27 Nov 1971).

A two-particle version of the Adler–Weisberger sum rule is obtained for cross sections of inclusive interactions using the technique of infinite momentum and an equal-time commutator in chiral SU(2) × SU(2). (L.B.S.)

10414 REGGEIZED DIFFERENTIAL CROSS SECTIONS FOR FERMION-EXCHANGE PROCESSES IN THE COVARIANT FORMALISM. Aye, T. M. (Imperial Coll. of Science and Tech., London). J. Phys., A (London): 4: No. 6, 846-55(Nov 1971).

A scheme developed by Scadron and Gault (1968, 1969, 1970) for calculating reggeized spin-averaged differential cross sections for boson exchange is extended, via s channel helicity vertices, to backward processes involving fermion Regge pole exchanges including those initiated by photons. (auth)

10415 PROPOSED CP- AND ISOSPIN-VIOLATING INTERACTION AND SYMMETRIES OF THE THREE-TRIPLET MODEL. Pati, Jogesh C. (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 7, 2143-52(1 Oct 1971).

The proposition made earlier that there exists a basic non-electromagnetic interaction at the level of electromagnetism, which violates isospin, C, CP, and T invariance "maximally", is reconsidered. It is found that the notion of this new interaction acquires several desirable features in the framework of the three-triplet model. They are: (a) the construction of partially conserved $\Delta S = \Delta Q = 0$, C-even and C-odd vector currents entering into the interaction; (b) the suppression of CP violation relative to isospin violation due to the new interaction; and (c) the possibility of a large contribution from the new interaction to the $\Delta I = 1$ mass differences without an appreciable contribution to the $\Delta I = 2$ mass differences. The $\eta \rightarrow 3\pi$ problem does not seem to have any simple solution in the present model if a vector form is considered for the new interaction. The possible advantages of a scalar form for the above interaction with respect to the $\eta \rightarrow 3\pi$ decay and the signs of the $\Delta I = 1$ mass differences are noted. Regardless of the vector or scalar form for the interaction, the suppression of CP and T violation in the present model will have the consequences that the asymmetry parameter for the $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ decay should be of the order of ½% and that the electric dipole moment of the neutron should lie in the region of $10^{-23} - 10^{-24}$ e cm, both of which estimates are an order of magnitude lower than the previous ones. It is emphasized that in addition to the above measurements, a search for the vector meson V^0 or alternatively the scalar meson S^0 (which mediates the new interaction) in the two-pion mass spectra would be most desirable to judge the existence of the new interaction. (auth)

10416 SECONDARY TRAJECTORIES IN INCLUSIVE REACTIONS. Chen, Min-shih; Paige, Frank E. (Brookhaven Nation Lab., Upton, N. Y.). Phys. Rev., D; 4: No. 7, 2163-5 (1 Oct 1971).

It is shown that some recent conjectures concerning duality in the single-particle spectrum for the reaction a + b → c + anything in the fragmentation region, together with factorization, imply the cancellation of leading secondary contributions in the central region for all reactions. A simple rule without this unlikely cancellation is pointed out and discussed. Some experimental tests concerning the secondary contributions are suggested. (auth)

10417 SUM RULE FOR THE Σ TERM FROM THE BJORKEN LIMIT AND MASS DISPERSION RELATIONS. Ng, Wing-chiu; Vinciarelli, Patrizio (New York Univ., N. Y.). Phys. Rev., D; 4: No. 7, 2079-83(1 Oct 1971).

A sum rule for the Σ term is derived from the assumptions of Bjorken limit, precocious asymptopia, and finite-mass dispersion relations. The commutation relations of the gluon model are used as input for a numerical evaluation. (auth)

10418 GIBBS PARADOX IN PARTICLE PHYSICS. Alexanian, Moorad (Instituto Politecnico Nacional, Mexico City). Phys. Rev., D; 4: No. 8, 2432-9(15 Oct 1971).

An attempt to understand the structure of particles by means of statistical mechanics is presented. This is accomplished by introducing the Gibbs paradox into particle physics. An interacting-particle model results with level density $\rho(m)$ in the range determined by $[\rho(m)]^{-1} = \phi(e^{-\beta m})$, $\beta > 0$, and $\rho(m) \leq e^{\gamma m \ln m}$, $\gamma > 0$, as $m \rightarrow \infty$. This result is to be contrasted to existing free-particle models which give an exponentially increasing mass spectrum. (auth)

10419 RELATIVISTIC TWO-VARIABLE EXPANSIONS FOR THREE-BODY DECAY AMPLITUDES. Hicks, H. R. (Carnegie-Mellon Univ., Pittsburgh); Winternitz, P. Phys. Rev., D; 4: No. 8, 2339-51(15 Oct 1971).

Three-body decays 1 → 2 + 3 + 4 are considered using a frame of reference analogous to the c.m. system for scattering. The physical decay region is mapped onto an O(4) sphere, so that the decay amplitude $f(\alpha, \theta)$ is a function on this sphere (depending only on two of the three angles α, θ, and ϕ). The amplitude is then expanded in terms of the basis functions of O(4) and two-variable expansions are obtained, in which all the dependence on the kinematic parameters is explicitly displayed in special functions. These expansions make it possible to treat decays and scattering on the same footing, in that they are intimately related to O(3,1) expansions of scattering amplitudes, considered previously. Some analyticity properties are built in, so that each partial wave has the correct behavior at the threshold $(m_3 + m_4)^2$ and pseudothreshold $(m_1 - m_2)^2$. The expansions make it possible to perform a kinematically (or group-theoretically) motivated harmonic analysis of Dalitz-plot distributions for K → 3π and η → 3π decays. (auth)

10420 TACHYONS WITHOUT CAUSAL LOOPS IN ONE DIMENSION. Antippa, Adel F. (Univ. of Quebec, Three Rivers); Everett, Allen E. Phys. Rev., D; 4: No. 8, 2198-2203(15 Oct 1971).

It is shown that, for the case of one spatial dimension, it is possible to formulate a theory of tachyons which is consistent with the special theory of relativity and involves no violation of causality. The preservation of causality requires the assumption that tachyons exist only with one sign of momentum. Although this assumption is not invariant under space inversion, it is consistent with the principle of relativity. In addition to the preservation of causality, a possible rationale for such an assumption is discussed briefly. (auth)

10421 FACTORISATION AND INCLUSIVE EXPERIMENTS. Halliday, I. G.; Parry, G. W. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B36: No. 1, 162-72(1972).

In the study of inclusive reactions where more than one particle is observed an application of Mueller's unitarity technique shows that one must study a certain discontinuity of the 4 → 4 amplitudes. It is shown using two models, the ladder diagrams in ϕ^3 perturba-

tion theory and Gribov's hybrid model, that this discontinuity factorizes in the multi-Regge limit. This has implications on the distribution of produced particles in inclusive experiments. (auth)

10422 CONSTRUCTING MASSIVE PARTICLES OUT OF MASSLESS PARTICLES IN THE NAMBU MODEL. Esch, R. J. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: No. 22, 2833-8(15 Nov 1971).

Massive particles can be constructed from a generalized bi-particle state of massless particles in the center of momentum using the Nambu interaction. The spectrum generated is fitted to the η_0^+ spectrum which uniquely determines the coupling constant and a cutoff. One of the renormalized masses of the fermion field is then shown to be approximately the physical mass of the muon. (auth)

10423 COMMENTS ON ISOSPIN ANALYSIS OF DIFFRACTION DISSOCIATION. Toernqvist, N. A. (Univ. of Helsinki). Commentat. Phys.-Math.; 41: 351-65(Dec 1971).

Some recent work on isospin analysis of pion production processes is commented, with special emphasis on the separation of Pomeron exchange. The common situation when two or more of the particles involved are identical (except for their charge), as in $\pi N \to \pi\pi N$ and $NN \to N\pi N$, is discussed in more detail, and the importance of possible interference effects is emphasized. (auth) (FINLAND)

Electromagnetic

Refer also to abstract 10683.

10424 (DESY-71/40) COMPARISON OF THE DIFFRACTION-DISSOCIATION MODEL FOR HIGH-ENERGY RHO PHOTOPRODUCTION WITH EMPIRICAL DATA. Kramer, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1971. 39p. Dep. NTIS (U. S. Sales Only).

Diffraction-dissociation models are compared for two-pion photoproduction in the p-wave state with recent data of the SLAC-Berkeley-Tufts Collaboration. Two models for the two-pion final-state interaction are considered. One is the model worked out earlier which leads to a monotonic modification of the $\pi^+\pi^-$ p-wave spectrum with momentum transfer and has for $t = 0$ the extra factor $(m_\rho/m)^4$ compared to the usual Breit–Wigner factor. The other model has a zero in the spectrum around $m = 1.1$ GeV which is shifted with momentum transfer. (auth)

10425 (FRNC-TH-117) SOME THEORETICAL PROBLEMS RELATED TO VECTOR MESONS AND e^+e^- ANNIHILATION INTERACTIONS. Cremmer, Eugene (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 69p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Annihilation experiments (e^+e^-) led to the study of three types of theoretical problem: radiative corrections, SU(3) charge commutation laws, and certain rare modes of decay such as the pseudoscalar meson + photon. The $\varphi \to K\bar{K}$ radiative corrections are discussed; the contribution of hadrons to the vacuum polarization corrections are also studied. The implications of the Jacobi identity in obtaining a consistent model, compatible with mass mixing, and the breaking down of SU(3) in different current algebra frameworks are considered. The sum rules derived from the previously discussed commutation laws are applied to the $\omega-\varphi$ mixture. The study of the pseudoscalar meson + photon decay mode enabled the dominance of vector mesons in the hadronic electromagnetic current to be studied together with the SU(3) symmetry, which allows the various identical modes to be interrelated. The importance of the $\omega-\varphi$ and $\eta\chi$ mixture is demonstrated. (France)

10426 TRANSPARENCIES OF COMPLEX NUCLEI TO PHOTOPRODUCED PIONS AND RECOIL NUCLEONS. de Carvalho, H. G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro); Martins, J. B.; Tavares, O. A. P.; Nazareth, R. A. M. S.; di Napoli, V. Lett. Nuovo Cim.; 2: No. 22, 1139-45(27 Nov 1971).

Nuclear transparancies are calculated for pions and recoil nucleons originated by interactions of high-energy photons with complex nuclei. The following reactions were considered: $\gamma n \to n\pi^0$, $\gamma n \to p\pi^-$, $\gamma p \to p\pi^0$, and $\gamma p \to n\pi^+$. Results are reported for nuclei ranging from $A = 12$ to 238 and for photon energies between 160 and 1000 MeV. (L.B.S.)

10427 PHOTOPRODUCTION OF CHARGED π MESONS AT HIGH ENERGIES. Panchokha, G. V. (Inst. of Theoretical Physics, Kiev. Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1095-8(Jul 1971). (In Russian).

A theoretical model is considered founded on taking into account the contributions of the π, ρ, B-Regge poles and scalar conspirator of the π-meson—π_c. This makes it possible to describe the data available on the photoproduction of π-mesons in the region of $0 \leq |t| \leq 1$ $(GeV/c)^2$: differential cross sections for the production of π^+-mesons, assymetry in the angular distribution of π-mesons in case of their production by linear-polarized photons, and the ratio of differential cross sections for production of π-mesons on neutrons and protons. (auth)

10428 LOW-ENERGY PHOTOPRODUCTION AND THE CHIRAL-TRANSFORMATION PROPERTY OF THE ELECTROMAGNETIC CURRENT. Cheng, T. P.; Dashen, Roger (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 4: No. 5, 1561-4(1 Sep 1971).

Using new multipole analyses of low-energy pion photoproduction, the possibility that the electromagnetic current does not commute with the axial charge F_5^3 is examined. Within errors, which are not as small as one would like, there is no evidence for a lack of commutation. It is pointed out that the photoproduction amplitude which directly measures this commutator receives very little contribution from the large, well-determined M_{1+} multipole and is dominated by the more exotic multipoles like E_{1+}. (auth)

10429 RESONANCES FROM ELECTRON–POSITRON COLLIDING BEAMS. Celeghini, E. (Univ., Florence. INFN, Florence). Rend. Scu. Int. Fis. Enrico Fermi; 46: 50-67(1971).

The production of baryon and meson resonances in colliding beams and the subsequent chains of decay processes are discussed. A compact formalism is developed to describe processes where the T-matrix is factorized and only three-leg vertices are present. The complete angular correlations are constructed in terms of a few parameters describing the vertices, taking also into account the eventual polarization of the initial particles. Speculations are made on the magnitude of the cross section, using a model based on pole dominance and universality. (L.B.S.)

10430 THEORY AND APPLICATIONS OF RADIATIVE CORRECTIONS. Etim, E. (Univ. of IFE, Ibadan, Nigeria). Rend. Scu. Int. Fis. Enrico Fermi; 46: 68-79(1971).

The infrared radiative corrections and their influence on colliding-beam reactions are considered in detail within the framework of the Bloch–Nordsieck theorem. The distribution function of energy loss due to soft-photon emission and for resonant processes is evaluated. The infrared correction factor $C(E,\Delta E)$ is calculated and plotted against E for various values of the ratio $\Delta E/E$. In conclusion, the connection between interference effects and radiative corrections is considered for the process $e^+ + e^- \to \pi^0 + \gamma$. (L.B.S.)

10431 THEORY OF e^+-e^- ANNIHILATION AT HIGH ENERGY. (SUM RULES, ASYMPTOTIC BEHAVIOURS, ALGEBRA OF COMPOUND FIELDS). Gatto, R. (Univ., Padua). Rend. Scu. Int. Fis. Enrico Fermi; 46: 80-140(1971).

Some questions relating to production of hadrons in electron-positron collisions at high energies are treated. In particular, the asymptotic behavior, the problem of Schwinger terms, spectral sum rules, and realizations of compound field albebra are discussed. (L.B.S.)

10432 REACTION $e^+e^- \to \pi^0 + \gamma$ AND $e^+e^- \to \eta + \gamma$. MEASUREMENT OF $\omega\phi$ AND $\eta\eta'$ MIXING ANGLES. Bacci, C. (Univ., Rome); Penso, G.; Salvini, G.; (and others). Rend. Scu. Int. Fis. Enrico Fermi; 46: 244-56(1971).

The processes $e^+e^- \to \pi^0\gamma$ and $e^+e^- \to \eta\gamma$ are discussed according to the first order graph and to the graph with a vector intermediate state. The general cross section for the first-order graph is first studied. The predictions of SU(3) and the quark model for the $\pi^0\gamma(\eta\gamma)$ decays of the ρ, ω, and ϕ intermediate states in $e^+ + e^-$ interaction and for the mixing angle are next studied. The Frascati experimental program for the $\pi^0\gamma$, $\eta\gamma$ final states is described. (L.B.S.)

10433 PREDICTIONS FOR COLLIDING-BEAM EXPERIMENTS AT 3 GeV AND SOME PLANS AT CEA. Wilson, Richard (CNEN, Frascati, Italy). Rend. Scu. Int. Fis. Enrico Fermi; 46: 453-511(1971).

Model predictions for pion and nucleon form factors, inelastic electron scattering, deep inelastic scattering, and $e^+ + e^-$ interactions are discussed. The apparatus being planned, designed, or constructed for colliding-beam experiments at CEA are discussed. These include the bypass on-line detector (BOLD) (nonmagnetic), the optical nonmagnetic detector, the 4π magnetic detector, and the less-than-4π magnetic detector (BOLDER). Some experiments planned are: the study of deviations from QED; a search for W-

particles and excited leptons; and a measurement of the total cross section to any hadron state. (L.B.S.)

10434 POLARIZATION OF THE RADIATION OF A MAGNETIC MONOPOLE MOVING IN A CONSTANT AND HOMOGENEOUS ELECTRIC FIELD. Kukanov, A. B.; Davydov, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 5, 516-17(May 1971).

In order to find the magnetic moment it is suggested to use the polarization properties of the bremsstrahlung of a magnetically charged particle moving in a constant and homogeneous electric field. The ratio of the total intensities of the radiation of magnetic and electric charges moving with the same velocities in circles of the same radius, respectively, in electric and magnetic constant homogeneous fields is given. (J.F.P.)

10435 DISCUSSION OF ISOTENSOR TERMS AND T VIOLATION IN PION PHOTOPRODUCTION NEAR THE FIRST RESONANCE. Berends, F. A. (Harvard Univ., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge); Weaver, D. L. Phys. Rev., D; 4: No. 7, 1997-2005(1 Oct 1971).

An analysis is made of the presently available experimental and theoretical information for pion photoproduction and π^- radiative capture near the first resonance with regard to the possibility of a violation of the $\Delta I \leq 1$ rule, and the possibility of a T-violating electromagnetic current. An isotensor term is only one of the several possible explanations of the recent π^- photoproduction data. The radiative-capture data near the first resonance support a substantial T violation in the magnetic dipole amplitude. However, it is not established that this T violation may be ascribed to a single isospin part of the amplitude. Some predictions for experimental tests are given which could clarify the situation. (auth)

10436 HADRON MOMENTUM DISTRIBUTION IN DEEPLY INELASTIC ep COLLISIONS. Chou, T. T. (Univ. of Denver); Yang, Chen Ning. Phys. Rev., D; 4: No. 7, 2005-11(1 Oct 1971).

Extending previous speculations originating from the idea that a hadron is a spatially extended object with many internal degrees of freedom, it is argued that in ep collisions in the deeply inelastic region, the proton partially fragments and partially pulverizes. The usefulness of studying experimentally the single-hadron spectrum for fixed and large q^2 and ν is discussed. (auth)

10437 PARTON MODEL WITH VARIABLE INTERMEDIATE-STATE PARTON MASS. Greenberg, O. W.; Bhaumik, D. (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 7, 2048-55(1 Oct 1971).

The parton model is modified by allowing the parton mass to change after absorbing the spacelike photon. Each prescription for the intermediate-state parton mass leads to a model with a definite scaling variable and to a scale-invariance-breaking factor which describes the approach to scaling. The model with Bloom et al.'s variable ω' has the required linear zero in νW_2 as $Q^2 \to 0$ for fixed ω, and has a scale-invariance-breaking factor which agrees with experiment for $1 \leq \omega' \leq 12$. The prescription that the parton mass must vanish after absorbing the photon leads to the scaling variable $\hat{\omega}$, which also occurs in the light-cone-singularity dominance model. Models which allow agreement of the sum rule for the mean squared charge per parton with experiment are given, as are models which have diffractive behavior for Q^2 near zero. (auth)

10438 MULTIPERIPHERAL THEORY OF DEEP-INELASTIC ELECTRON–NUCLEON SCATTERING. Shei, Sun-sheng; Tow, Don M. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 7, 2056-64(1 Oct 1971).

The Amati-Bertocchi-Fubini-Stanghellini-Tonin multiperipheral model is modified to study deep-inelastic electron-nucleon scattering. The behavior of the structure functions is derived in the limit of large energy and momentum transfer, ν and q^2, with $\omega \equiv 2m\nu/(-q^2)$ fixed but large. In particular, scaling is derived. To accomplish this derivation it is necessary to introduce a cutoff for the momentum transfer of the exchange nucleon, which directly couples to the photon in the multiperipheral chain. The multiperipheral derivation is compared with derivations that use other models. The generality of our derivation, in the sense of requiring only Regge behavior and a particular asymptotic off-shell dependence, is discussed. (auth)

10439 PARAMETRIZATION OF CHARGED-PION PHOTOPRODUCTION IN TERMS OF COMPLEX REGGE POLES. Ball, J. S.; Mueller, H. J. W.; Pal, B. K. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 7, 2065-70(1 Oct 1971).

A fit of forward charged-pion photoproduction data is attempted by parametrizing Regge pole-cut combinations in the region $t < 0$ in terms of complex conjugate pairs of Regge poles. In particular, the pion-Pomeranchukon cut is taken into account by this parametrization; in addition to the pion, exchange of the A_2 meson is considered. Predictions are made for the differential cross section and the asymmetry parameters for pion production by linearly polarized photons and polarized target nucleons. The results are found to be in good agreement with pion photoproduction data for laboratory photon energies ranging from 3.4 to 18 GeV and t values up to -0.2 $(GeV/c)^2$. (auth)

10440 INELASTIC-COMPTON-SCATTERING INEQUALITIES IN THE QUARK–PARTON MODEL. Goswami, D. N.; Majumdar, D. P. (Syracuse Univ., N. Y.). Phys. Rev., D; 4: No. 7, 2090-4(1 Oct 1971).

On the assumption that partons are quarks, several constraint relations (in the form of inequalities) are derived for the structure functions of inelastic Compton scattering. Bounds on the structure functions of the inelastic Compton scattering with respect to those of inelastic electron-proton scattering are also discussed. All these inequalities must be true for any quark-parton model and, thus, furnish us with some means of testing the hypothesis of individual quark-parton identification. These are also very useful for obtaining information about the parton distribution function P(N) and about the minimum number of partons N_0 in a nucleon. The constraint relations that are derived here can be made much stronger if one uses a detailed quark-parton model. Assuming $\langle 1/N \rangle = 0.1$, which is consistent with the presently available data on both inelastic electron and inelastic neutrino scattering, a quantitative analysis is made of the structure functions. (auth)

10441 HOW TO SEE THE LIGHT CONE. Gross, David J.; Treiman, S. B. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 7, 2105-14(1 Oct 1971).

New experiments which probe the behavior of products of electromagnetic currents at short and lightlike distances are investigated. They require the detection of a massive μ pair in electron-positron annihilation or in electroproduction. The former reaction is studied in detail and the (considerable) background is discussed. It is shown that, in suitable kinematic regions, one can approach both the Bjorken–Johnson–Low limit and the scaling limit, and put to severe test many recent ideas regarding products of currents. In the Bjorken–Johnson–Low limit one can test models of equal-time commutation relations and measure the spectral functions of an axial-vector current. In the scaling region one can measure the matrix elements of the bilocal operators appearing in the light-core expansion of the product of electromagnetic currents, and test the tensorial structure of this expansion which emerges from quark models. Finally, in the inclusive reaction, where a massive μ pair is produced in addition to any number of hadrons, the large hadronic mass limit of the cross section is completely determined in terms of a commutator of bilocal operators. (auth)

10442 TOTAL CROSS SECTION FOR ELECTRON–POSITRON ANNIHILATION AND HADRONIC CONTRIBUTION TO THE MUON MAGNETIC MOMENT. Langacker, Paul; Suzuki, Mahiko (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 7, 2160-2(1 Oct 1971).

A class of rigorous inequalities are derived for the integrated cross section for e^-e^+ annihilation into hadrons through one photon. They involve the p-wave $\pi\pi$ cross section and a slope of the electromagnetic form factor of the pion. A lower bound on the hadronic contribution to the muon magnetic moment is estimated in terms of the electromagnetic charge radius r_π. The bound is twice as large as the ρ-meson dominance value if $r_\pi = 0.86$ F as indicated by old data, but no meaningful result is obtained if one substitutes the values for r_π obtained in a new experiment. The inequalities can also be used to test various predictions concerning the asymptotic behavior of the e^-e^+ annihilation cross section. A slowly decreasing behavior is favored over a rapidly decreasing one like $\sigma^{e^+e^-}(t) \propto t^{-3}$, but more accurate data are needed to draw a definite conclusion. (auth)

10443 FORMATION OF $P_{11}(1470)$ RESONANCE IN THE γ-n INTERACTION. Carbonara, F. (Istituto Nazionale di Fisica Nucleare, Naples. Univ., Naples); Fiore, L.; Gialanella, G.; (and others). Lett. Nuovo Cim.; 2: No. 23, 1183-9(4 Dec 1971).

The formation of the $P_{11}(1470)$ in pion photoproduction on nucleons was investigated from an analysis on total and differential cross sections of the reaction $\gamma + n \to p + \pi^-$, and a fit to the pion–nucleon effective-mass distributions in the reactions $\gamma n \to n\pi^+\pi^-$ and $\gamma p \to p\pi^+\pi^-$. It is concluded that the $P_{11}(1400)$ is strongly photoexcited on nucleons and that the P_{11} does not decay in $\Delta + \pi$. (auth)

10444 APPROXIMATE RADIATIVE CORRECTIONS FOR ELECTRON–PROTON SCATTERING THROUGH A RENORMALIZATION-GROUP APPROACH. Campbell, J. A. (Univ. of Texas, Austin). Aust. J. Phys.; 24: No. 5, 653-60(Oct 1971).

A method of estimating the effect of radiative corrections for electron–proton scattering to all orders in the fine-structure

constant, given the lowest-order correction, is proposed. It is based on an expansion of the cross section in which the coefficients are fixed by constraints imposed by the multiplicative renormalization group. Difficulties of nonrenormalizability of the physical proton are avoided because of an approximation which is already used on other grounds in previous calculations of the lowest-order radiative correction. (auth)

10445 CHARGE MOVING WITH THE SPEED OF LIGHT IN EINSTEIN–MAXWELL THEORY. Bonnor, W. B. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 3: No. 1, 57-65(Feb 1970).

Solutions of the Einstein–Maxwell equations are given describing a charge moving with the speed of light, c. The motion generates plane-fronted electromagnetic and gravitational waves. Charges moving parallel to each other with speed c do not interact; nor do they interact with parallel light beams. (auth)

10446 ELECTRIC CHARGE SYSTEMS MOVING WITH VELOCITY OF LIGHT AND ASSOCIATED WITH CHARGE CREATION. Chambers, Ll. G. (University Coll. of North Wales, Bangor). Int. J. Theor. Phys.; 3: No. 5, 413-24(Oct 1970).

A discussion is given of certain electromagnetic fields associated with charges moving with the velocity of light which are associated with zero magnetic field and the creation of charge. The stress energy tensor associated with charge creation is also discussed and it is shown that the stress energy tensor includes a term which may be interpreted as a shear. (auth)

10447 ELECTRIC CHARGE SYSTEM MOVING RADIALLY WITH VELOCITY OF LIGHT. Chambers, Ll. G. (University Coll., of North Wales, Bangor). Int. J. Theor. Phys.; 4: No. 1, 11-17(Feb 1971).

A solution is found for Maxwell's equations which are associated with a radial flow of electric charge moving with the speed of light. (auth)

10448 DISPERSION RELATIONS FOR BHABHA SCATTERING AMPLITUDES. Skontrop, O.; Haug, A. (Univ. of Oslo). Phys. Norv.; 5: No. 1, 73-86(1971).

Fixed-momentum transfer dispersion relations for the second order Born approximation to the Bhabha scattering amplitudes are presented, the discontinuities being obtained from unitarity. Double spectral functions are calculated for the purpose of checking contributions to the discontinuities. (Norway)

10449 DIFFERENTIAL CROSS SECTION FOR PAIR PRODUCTION BY PHOTONS ON ELECTRONS. Mork, K. J. (Univ. of Trondheim, Norway). Phys. Norv.; 5: No. 1, 51-6(1971).

The differential cross section for pair production by unpolarized photons in the field of an electron was computed in lowest order perturbation theory using covariant sums over polarizations. The contributions to the cross section from the different Feynman diagrams are given separately, and the kinematics of the process are discussed for some cases. (Norway)

10450 ASYMPTOTIC BEHAVIOR OF FORM FACTORS IN FIELD THEORY. Applequist, Thomas; Primack, Joel R. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 4: No. 8, 2454-75(15 Oct 1971).

Some calculations are given concerning the asymptotic behavior of the electromagnetic form factor in a field-theory model consisting of fermions and massive vector gluons. The result of summing the leading terms in each order of perturbation theory is $F_{1p}(q^2) = \exp[-(g^2/16\pi^2)\ln^2(-q^2/\mu^2)]$, where q is the momentum transfer, and g and μ are the vector-gluon coupling constant and mass. This result is easily proven in an eikonal-type approximation. It is furthermore shown that in the vector-gluon model this eikonal approximation correctly reproduces the exact leading asymptotic behavior of all of the vertex graphs with leading contributions in each order of perturbation theory — in contrast to the scalar φ^3 theory, where an eikonal approach has recently been shown to fail. The result for the form factor is compared with the data; the physical mechanism producing rapid falloff of the form factor is discussed; and various other theoretical implications of these calculations are suggested. (auth)

10451 CONSISTENCY RELATION AMONG ELASTIC AND INELASTIC ep AND pp CROSS SECTIONS. Benofy, L. P.; Shrauner, E. (Washington Univ., St. Louis). Phys. Rev., D; 4: No. 8, 2447-54(15 Oct 1971).

A consistency relation or sum rule is derived among elastic and inelastic electron–hadron and hadron–hadron scattering cross sections that is a generalization of the Wu-Yang conjecture. It is shown that in the case of pp scattering (pp → p + anything) the cross-section data can be represented in an energy-independent form which allows a simple and direct application of our sum rule. (auth)

10452 INELASTIC e–p SCATTERING IN MASSIVE QUANTUM ELECTRODYNAMICS. Fishbane, P. M.; Sullivan, J. D. (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 8, 2516-33 (15 Oct 1971).

The leading contributions to νW_2 are calculated, in the deep-inelastic region, in each order of perturbation theory for quantum electrodynamics with massive photons. Scaling is broken by $\ln Q^2$ factors which come from both transverse and longitudinal phase-space integrations and which exponentiate in an elegant eikonal-like form. The important final states are characterized by a single "hard" proton and multiple "soft" meson production; $\langle n \rangle \sim \ln^2 Q^2$. There is an intimate relationship between the elastic form factor and the inelastic structure function νW_2. A Drell–Yan–West relation holds after a slight generalization to accommodate the logarithmic violation of scaling. (auth)

10453 INFINITE-COMPONENT WAVE EQUATIONS IN THE EXTERNAL ELECTROMAGNETIC FIELD. Pavkovic, Marko I. (Tel-Aviv Univ., Ramat-Aviv, Israel). Phys. Rev., D; 4: No. 8, 2534-44(15 Oct 1971).

The properties of a large class of infinite-component relativistic wave equations are investigated after the inclusion of the external electromagnetic fields. The external electromagnetic fields are introduced by applying the familiar prescription $p \rightarrow p - eA$, which guarantees gauge invariance. In the expression for the energy of the particle in the external field, terms which are familiar from the formalism of the Dirac particle in the external field are first recognized, and then the presence of new terms which are characteristic of the composite structure are noted. The well-known $\vec{L} \cdot \vec{H}$ term, which describes the interaction of particle spin $\vec{L}$ with the external magnetic field $\vec{H}$, appears multiplied by a constant too small to account for the experimental value of the magnetic moment of the proton. In some models, this constant can also be negative or can vanish. The results go beyond reconfirming early suspicions that, unlike the situation with the Dirac electron, the electromagnetic properties of composite particles described by the infinite-component wave equations cannot be accounted for exclusively by the prescription $p \rightarrow p - eA$. The magnetic moment associated to the procedure $p \rightarrow p - eA$ is established as a highly model-dependent physical quantity, and the mechanism which is responsible for the large variations in its value is identified. The unreasonable physical predictions concerning the magnetic moment can always be remedied through the addition of the phenomenological Pauli interaction term $L_{\mu\nu}F^{\mu\nu}$, multiplied by an appropriate real constant. (auth)

10454 CAN THE PERTURBATION-THEORETIC APPROACH TO PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT INCLUDE ELECTROMAGNETISM. Weinstein, Marvin (New York Univ., N. Y.). Phys. Rev., D; 4: No. 8, 2544-64(15 Oct 1971).

It has become apparent that the successes of partial conservation of axial-vector current (PCAC) — when applied to purely hadronic processes — can be explained using nothing more than the idea of a naive perturbation-theoretic expansion about an SU(3) ⊗ SU(3)-symmetrical limit. A simple formalism is presented for extending this perturbation-theoretic approach to include electromagnetism. The advantage of this formalism is that it enables the tight relationship between $\eta - \pi^0$ mixing, the electromagnetic mass differences of the pseudoscalar mesons, and the decay $\eta \rightarrow \pi^+\pi^-\pi^0$ to be exhibited. A formula is derived relating the $\eta - \pi^0$ mixing parameter $C_{\pi\eta}$ to the electromagnetic mass differences of the pseudoscalar mesons. It is shown that if one uses the value for $C_{\pi\eta}$ determined by this formula ($C_{\pi\eta} \cong 0.01$), then the most naive application of these ideas to the decays $\eta \rightarrow \pi^+\pi^-\pi^0$, $\pi^0 \rightarrow \gamma\gamma$, and $\eta \rightarrow \gamma\gamma$ is remarkably successful. However, if one assumes conventional SU(3) ⊗ SU(3) transformation properties for the electromagnetic Hamiltonian αH_{em}, this treatment is seen to have problems of its own, in that terms of second order in perturbation theory must be as large as first-order terms. It is shown that a self-consistent perturbation-theoretic treatment of PCAC plus electromagnetism is possible only if the chiral transformation properties of αH_{em} are unusual. The consequences of such an assumption for the processes mentioned are examined in detail, and a brief discussion of the experimental significance of such anomalous SU(3) ⊗ SU(3) transformation properties for αH_{em} is given. (auth)

10455 EFFECTS OF DAUGHTERS ON ELECTROMAGNETIC MASS DIFFERENCES. Dicus, Duane A.; Teplitz, Vigdor L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 8, 2313-19(15 Oct 1971).

A procedure was suggested for computing $\Delta I = 1$ electromagnetic mass differences by using a finite-energy sum rule to com-

pute the subtraction function in the dispersion relation for the amplitude $t_1(q^2,\nu)$ which appears in the Cottingham formula; Regge residues appearing in the subtraction function are found from a superconvergence relation. The present work considers the effect of the inclusion of asymptotic nonleading power behavior on the results of this procedure; a surprising sensitivity is found. In particular, it is shown that in evaluating the superconvergence relation, the hypothesis of A_2 dominance of high-energy virtual Compton scattering from K mesons is only tenable for an extremely narrow range of the ratio of the longitudinal to transverse total virtual Compton cross sections. (This range does not include zero.) The effects of O(4) symmetry are discussed, comment is given on the more complicated nucleon mass-difference problem, and the Cottingham formula is applied to nuclear mass differences. (auth)

10456 ELECTROPRODUCTION OF ω-MESONS AS A TEST OF THE $\rho\omega\pi$-VERTEX. Fraas, H. (Univ., Wuerzburg, Ger.). Nucl. Phys.; B36: No. 1, 191-204(1972).

A simple model for electroproduction of ω-mesons is presented. The nondiffractive part is described by elementary OPE without corrections, combined with vector-meson dominance. For the diffractive production amplitudes helicity conservation in the direct channel is assumed. The differential cross section and the spin-density matrix of the ω-mesons are discussed, particularly emphasizing the dependence on the mass of the virtual photon and the possibility to test the mass-dependence of the $\rho\omega\pi$ coupling constant. (auth)

10457 VECTOR-MESON DOMINANCE AND $\pi\Delta(1236)$ ELECTROPRODUCTION. Bartl, A. (Univ., Tuebingen, Ger.); Schildknecht, D. Nucl. Phys.; B36: No. 1, 28-44(1972).

Predictions for $\pi\Delta(1236)$ electroproduction are given within the framework of vector-meson dominance. Comparison with experimental results on $ep \to e\pi^+\Delta^0$ shows good agreement. (auth)

10458 VACUUM POLARIZATION IN MAGNETIC FIELD. Constantinescu, D. H. (Scuola Normale Superiore, Pisa, Italy). Nucl. Phys.; B36: No. 1, 121-9(1972).

The dispersive properties of free space in the presence of a magnetic field are calculated in the lowest order in the fine-structure constant, but exactly in the field. An integral representation of the corresponding index of refraction is written exhibiting the dispersive and birefringent properties of the vacuum, with absorption coming in for transverse photon momenta above the pair production threshold. The weak-field limit and the dominant behavior in strong fields are explicitly calculated. (auth)

10459 KINEMATIC CUTS AND BACKWARD PHOTOPRODUCTION. Pond, P.; Kumar, Arvind (Westfield Coll., London). Nucl. Phys.; B36: No. 1, 241-52(1972).

A phenomenological analysis of backward photoproduction is presented in terms of the recently proposed kinematic cut model. The cut fills in the dip at $u \approx -0.15$ without having to invoke the Ny trajectory. Good agreement with the data is obtained in the scattering region; the extrapolation to the nucleon pole is unsatisfactory. (auth)

10460 DISPERSION RELATIONS AND THE ISOTENSOR ELECTROMAGNETIC CURRENT IN PION PHOTOPRODUCTION. Devenish, R. C. E. (Univ. of Lancaster, Eng.); Lyth, D. H.; Rankin, W. A. Nucl. Phys.; B36: No. 1, 309-16(1972).

Dispersion relations are evaluated for single pion photoproduction in the first resonance region. The imaginary parts are saturated by the first and nine other resonances, up to mass 2.0 GeV. The results are compared with experiment for total cross sections for π^0, π^+ and π^- production. The coupling of the Δ to γn has to be smaller than that to γp, by about 30%. The effect of the higher resonances is small but not insignificant. The ability of unitarity to make predictions is explored, both in principle and in practice. (auth)

10461 ELECTROPRODUCTION OF PIONS BY POLARIZED ELECTRONS ON POLARIZED PROTONS. Omelaenko, A. S. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 14: No. 6, 268-9(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6, 395-7(20 Sep 1971).

The cross section of the interaction $e + p \to e + n(p) + \pi^+(\pi^0)$ in the region of the first nucleon resonance is estimated for conditions of an experiment in which only the scattered electron is registered, and e and p are assumed polarized. (J.F.P.)

10462 ELECTRIC PARTICLE PAIR PRODUCTION AT HIGH ENERGIES. Baier, V. N.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 2, 476-89(Aug 1971). (In Russian).

The production of pairs of spin-0 or -½ particles in collisions between two high-energy charged particles is considered. Terms involving the third, second and in a number of important cases also the first power of the logarithm are found in the cross section for the process which increases logarithmically with energy. Along with the total cross section a number of differential cross sections are derived which are used for analyzing the angular and energy distributions of the final particles. (auth)

10463 EFFECT OF GEOMAGNETIC FIELD ON THE ANGULAR DISTRIBUTION OF PARTICLES IN ELECTROMAGNETIC CASCADES. Guzhavin, V. V.; Ivanenko, I. P.; Makarov, V. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 14: No. 5, 1006-13(Nov 1971). (In Russian).

The system of basic equations of three-dimensional cascade theory is derived with the account of effect of geomagnetic field on the motion of charged shower particles in the atmosphere. The functions of the angular distribution of cascade electrons and positrons in the atmosphere for various values of the cascade parameter s are calculated by the momentum method. (auth)

10464 EFFECT OF CONSTANT ELECTROMAGNETIC FIELD ON ELECTRON–POSITRON PAIR PHOTOPRODUCTION. Zhukovskii, V. Ch.; Kherrmann, I. (Moscow State Univ.). Yadern. Fiz.; 14: No. 5, 1014-19(Nov 1971). (In Russian).

The probability is obtained of the e^+e^- pair production on collision of a hard γ quantum with a plane electromagnetic wave in a constant external field. It is shown that in presence of an external field the two-photon pair production beneath the reaction threshold becomes possible. (auth)

10465 HIGHER-ORDER EFFECTS IN EXTERNAL FIELD: PAIR PRODUCTION BY A PARTICLE. Baier, V. N.; Katkov, V. M.; Strakhovenko, V. M. (Novosibirsk State Univ., USSR). Yadern. Fiz.; 14: No. 5, 1020-6(Nov 1971). (In Russian).

Probability of pair production by a relativistic particle in an external electromagnetic field is calculated using a generalization of the operator method proposed recently. The cases of spin 0 and ½ are considered. At $\chi = (e\hbar/m^3c^4)\sqrt{|(F_{\mu\nu}p^\nu)^2|} \ll 1$ the probability is exponentially small. At $\chi \gg 1$ the probability is $\sim a^2\chi \ln \chi$. As for the lower-order processes, the probabilities are $\sim a\chi^{\frac{2}{3}}$. (auth)

10466 ELECTRON–POSITRON PAIR PHOTOPRODUCTION ON ELECTRONS AND ANALYSIS OF PHOTON BEAM POLARIZATION. Boldyshev, V. F.; Peresun'ko, Yu. P. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 5, 1027-32(Nov 1971). (In Russian).

The effective cross section differential in the azimuthal angle of the recoil electrons by linearly polarized photons in the electron field is calculated. The cross section asymmetry slowly decreases from 30% at the 10 MeV photon energy down to 14% in the far asymptotics. The possibility of applying the effect to the analysis of the photon beam polarization is discussed. (auth)

10467 HADRON CONTRIBUTION TO CORRECTION DUE TO VACUUM POLARIZATION IN PHOTON PROPAGATOR AND ANOMALOUS MAGNETIC MOMENT OF THE MUON. Petrun'kin, V. A.; Startsev, S. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 5, 1033-43(Nov 1971). (In Russian).

Corrections due to the hadron vacuum polarization (h.v.p.) are calculated in the photon propagator as well as the muon anomalous magnetic moment (a.m.m.) in the lower order in fine-structure constant α. The corrections are expressed as an integral of a known function multiplied by the total cross section of annihilation e^- with e^+ into hadrons $\sigma^*_{tot}(s = -(p_+ + p_-)^2)$. Numerical estimates are obtained under the following assumptions: (1) for s from $4m_\pi^2$ up to 1.05 GeV^2 the cross section $\sigma^*_{tot}(s)$ is described by the vector dominance model, (2) in the region of s from 1.05 GeV^2 up to ∞ the cross section σ^*_{tot} (s) has no resonances and decreases no slower than 1/s. The calculated corrections due to h.v.p. to the cross section $(d\sigma/d\Omega)$ $(e^- + e^+ \to e^- + e^+)$ and $(d\sigma/d\Omega)$ $(e^- + e^+ \to \mu^- + \mu^+)$ do not exceed 5% in the energy region 1.4 to 7 GeV and the upper limit of correction to the a.m.m. of the muon is $9(10)^{-8}$ in Bohr magnetons. (auth)

10468 GENERALIZED SCALING LAWS FOR THE ELECTROPRODUCTION OF HADRONS. Stack, John D. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 28: No. 1, 57-60(3 Jan 1972).

The light-cone structure suggested by the quark model is used to propose a generalized scaling law in electroproduction with detection of one final hadron. At fixed momentum transfer between initial and final hadrons, the cross section scales in two variables: the usual Bjorken variable and the fractional longitudinal momentum of the final hadron. (auth)

Weak

Refer also to abstracts 10551, 10602, and 10787.

10469 EXPERIMENTAL VERIFICATION OF WEAK INTERACTIONS AND THE MUON PUZZLE. Telegdi, V. (Univ. of Chicago). Fields Quanta; 2: No. 2, 137-73(Nov 1971).

A lecture is given on the properties and weak interactions of the muon. (J.F.P.)

10470 NONLEPTONIC DECAY AND THE CURRENT x CURRENT THEORY. Pakvasa, S. (Univ. of Hawaii, Honolulu); Rosen, S. P. Fields Quanta; 2: No. 2, 93-136(Nov 1971).

A survey is given of the current x current theory analysis of nonleptonic decay. It is found that the existence of parity-violating nuclear forces in general supports the current x current theory, and the data do not contradict the conventional form of the interaction. (J.F.P.)

10471 SPIN SUMMATION IN THE CASE OF THE LONGITUDINAL POLARIZED NEUTRINO. Fakirov, D. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 153-7(1971). (In Bulgarian).

It is known that the neutrino as a massless particle has only two polarization states. When estimating the matrix elements, which ultimately yield cross sections or probabilities, the disappearance of the spinnor describing the neutrino is such as for particles with four polarizations. But this, even from a methodological point of view, is incorrect. An alternative for avoiding the difficulty thereby created is offered: the neutrino is considered to have a mass, and in the end a limiting transformation is made to a zero neutrino mass. (auth)

10472 ELASTIC SCATTERING OF ELECTRONS BY SOLAR NEUTRINOS AND WEAK INTERACTION THEORIES. Chaudhuri, P. R. (Indian Statistical Inst., Calcutta). J. Phys., A (London): 4: No. 6, 109-11(Nov 1971).

The counting rate of recoil electrons for the elastic scattering of electrons by solar neutrinos, considering that the CNO cycle is responsible for nuclear energy generation in the sun, is calculated according to the photon–neutrino weak coupling theory as well as the current–current coupling theory. It is suggested that this result can be used to decide which type of weak interaction exists in nature. (auth)

10473 DEEP-INELASTIC NEUTRINO SCATTERING IN A RESONANCE MODEL. Domokos, G.; Kovesi-Domokos, S.; Schonberg, E. (Johns Hopkins Univ., Baltimore). Phys. Rev., D; 4: No. 7, 2115-25(1 Oct 1971).

Deep-inelastic neutrino scattering is investigated in the framework of a direct-channel resonance model. Using empirical properties of the baryon spectrum and making a universality hypothesis for the transition form factors, it is deduced that in the Bjorken limit the structure functions W_1, νW_2, and νW_3 become functions of the scale variable (ratio of center-of-mass energy to momentum transfer) alone. By imposing generalized Goldberger–Treiman–Nambu relations on the axial-vector transition matrix elements and fixing the coupling constants from low-energy experiments, all structure functions are predicted without free parameters. The predictions of the theory are compared with neutrino scattering data obtained at CERN. Good agreement is found between theory and experiment in the deep-inelastic region. (auth)

10474 PHYSICAL PROCESSES IN A CONVERGENT THEORY OF THE WEAK AND ELECTROMAGNETIC INTERACTIONS. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett; 27: No. 24, 1688-91(13 Dec 1971).

A previously proposed theory of leptonic weak and electromagnetic interactions is found to be free of the divergence difficulties present in conventional models. The experimental implications of this theory and its extension to hadrons are briefly discussed. (auth)

10475 CONTRIBUTION TO KAON DECAYS OF DIRECT ISOSPIN-VIOLATING NONELECTROMAGNETIC INTERACTIONS. Goyal, Ashok (Univ. of Pennsylvania, Philadelphia); Li, Lingfong. Phys. Rev., D; 4: No. 7, 2012-16(1 Oct 1971).

The effect of an isospin-violating nonelectromagnetic term U_3 on $K \to 2\pi$ and $K \to 3\pi$ decays is discussed. With the coefficient of the term U_3 compatible with electromagnetic mass differences, the contribution is too small to explain the $(K^+ \to \pi^+\pi^0)/(K_1^0 \to 2\pi)$ decay ratio and the deviations from the $|\Delta I| = \frac{1}{2}$-rule prediction of slope parameters in $K \to 3\pi$ decays. (auth)

10476 EXACT INEQUALITY AND TEST OF CHIRAL SW(3) THEORY IN K_{l3} DECAY PROBLEM. Okubo, Susumu; Shih, I-Fu (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 7, 2020-9 (1 Oct 1971).

Assuming the chiral SW(3) model, exact inequalities for the K_{l3} scalar form factor D(t) and its derivatives were studied. The inequalities can be sharpened considerably if the soft-pion theorum is taken into account. These inequalities are stringent enough to test the validity of the chiral SW(3) theory. (auth)

10477 NEUTRAL (V + A) CURRENTS AND WEAK LEPTON–LEPTON SCATTERING. Romanov, Yu. I. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 64-8(1971). (In Russian).

Symmetrical "neutral" (V + A)-currents are introduced for the purpose of describing weak scattering processes, accompanied by a change in the nature of the primary particles. Spin correlations in neutrino-electron (muons) and electron-electron (positron, muons) scattering were investigated with the aid of current-current "neutral" (V + A)-schemes. (tr-auth)

10478 SUM RULE FOR THE RARE DECAY MODES OF KAONS. Chand, Prakash (Colorado State Univ., Fort Collins). Int. J. Theor. Phys.; 3: No. 2, 141-4(Apr 1970).

An exact sum rule is found for the K_{e4} decay of kaons and it is modified to account for the possible charge and parity nonconservation. (auth)

10479 REALISATIONS OF THE REPRESENTATIONS OF PARA-FERMI ALGEBRAS. PART IV. FOCK SPACES OF PARA-BOSE AND PARA-FERMI OPERATORS. Kademova, K. V.; Kraev, M. M. (Inst. of Physics, Sofia). Int. J. Theor. Phys.: 4: No. 2, 159-70(Apr 1971).

The representations of the para-Fermi algebra in the Fock spaces of para-Bose and para-Fermi operators are constructed. The unitary equivalence of different representations is proved. The Bardeen–Cooper–Schrieffer pair creation and annihilation operators and the four fermion interaction appear as particular realizations of the para-Fermi algebra. The para-Fermi algebra representations in quantum mechanics are discussed. (auth)

10480 INELASTIC LEPTON SCATTERING IN GLUON MODELS. Smith, C. H. Llewellyn (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 8, 2392-7(15 Oct 1971).

A formal study of quark models with interactions due to scalar, pseudoscalar, or vector fields is presented. It is shown that all the results which have been derived in quark-parton models in which the details of the nucleon's constitution are not specified can be obtained formally using naive canonical manipulations of operators. In the case that there is no vector field some new results are obtained which would provide an experimental measurement of the proportion of scalar or pseudoscalar gluons in the nucleon. (auth)

10481 CHIRAL FIELD ALGEBRA AND K_{l4} DECAYS. Gottlieb, H. P. W. (Cambridge Univ., Eng.). Nucl. Phys.; B36: No. 1, 278-300(1972).

The method of maintaining the minimality of the number of derivatives in a Lagrangian with spin-zero and spin-one mesons, introduced for chiral SU(2) × SU(2) by Ogievetsky and Zupnik, is generalized as far as necessary to SU(3) × SU(3). Complete field algebra is also preserved. The formalism is applied to the calculation of K_{e4} axial-vector form factors and decay rates and achieves good agreement with experiment. Various soft-pion limits are also considered, to investigate the conditions under which the Callan–Treiman–Weinberg relations may be obtained. (auth)

10482 WEAK INTERACTIONS OF COLLIDING LEPTON BEAMS IN THE REGION 10^2 TO 10^3 GeV. Dolgov, A. D.; Zakharov, V. I.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 5, 1044-54(Nov 1971). (In Russian).

Weak V–A interaction of charged lepton currents at high energies is considered. A hypothesis is made that the only dimensional parameter of the theory is the value of the weak constant G and that the deviation of the weak process amplitude from the low-energy behavior takes place only at $Gs \gtrsim 1$. It is shown that at the energies of colliding beams 2×250 GeV the scattering $e^+e^- \to e^+e^-$ by angle 90° due to weak interaction (in G^2 order) must be larger than due to electromagnetic interaction. The value of the weak cross section amounts to $\sim 4(10)^{-37}$ cm^2·sterad.$^{-1}$. The imaginary part of the amplitude in this case is calculated uniquely. The real part of the crossing-symmetrical amplitude, if the usual dispersion relations hold, has a definite sign and its value depends on the cross section behavior above the unitary limit. Analogous consideration is applied to the processes $e^-e^- \to e^-e^-$ and $e^+e^- \to \mu^+\mu^-$. (auth)

10483 CALCULATION OF PION SPECTRA AND PROBABILITY RATIOS OF DIFFERENT MODES OF $K \to 3\pi$ DECAY. Anisovich, V. V.; Volkovitskii, P. E. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 14: No. 5, 1055-65(Nov 1971). (In Russian).

The amplitude of $K \to 3\pi$ decay contains terms of two different kinds. The first one depends analytically on the pion energies

while the second does not. The last terms are connected with the pion rescattering. Singular parts of the amplitude are calculated up to $a_1^4(mE)^2$ (a_1 and m are the pion scattering length and the pion mass, E is the energy released in decay). The expressions for spectra are given with such precision. Supposing the transitions with $\Delta I = \frac{1}{2}$ to be small, the expression $R^{+-}/4R^{00+} - 3R^{+-0}/2R^{000}$ (here R are the decay probabilities) is calculated up to $a_1^5(mE)^5$. The region of possible values of scattering length due to the experimental value of the above expression is given. (auth)

Strong (General)

10484 SU_6 QUARK MODEL. O'Neill, G. K. (Princeton Univ., N. J.). Rend. Scu. Int. Fis. Enrico Fermi; 46: 194-220 (1971).

As an introduction to SU(6) some definitions are given and the essential points of SU(2) and SU(3) are outlined. The construction of mesons and baryons in the SU(6) quark model is then treated in detail. Predictions for the nucleon magnetic moment ratio and for hadron scattering are discussed. (L.B.S.)

10485 KAON PRODUCTION AND MULTIPERIPHERAL DYNAMICS. Gyuk, I.; Snider, Dale R. (Univ. of Wisconsin, Milwaukee). Phys. Rev., D; 4: No. 7, 2083-9(1 Oct 1971).

Using experimental data on the pion momentum distribution, together with the dynamics of the multiperipheral model, it is shown that the asymptotic energy dependence of the total nonstrange cross section and of the total cross section differ only slightly. The difference is determined by the energy dependence of the kaon production rate. (auth)

10486 DETERMINATION OF ASYMPTOTIC PARAMETERS IN THE STATISTICAL BOOTSTRAP MODEL. Hamer, C. J.; Frautschi, S. C. (California Inst. of Tech., Pasadena). Phys. Rev., D; 4: No. 7, 2125-37(1 Oct 1971).

The statistical bootstrap model predicts that the density of hadron states $\rho(m)$ approaches $cm^a e^{bm}$ asymptotically. The consequences of extending the bootstrap condition in the model from asymptotic down to finite masses. This allows us to determine the parameters a, b, and c for various assignments of the hadron volume and low-mass input spectrum, and for the extreme cases of excluding all exotic particles or including all of them. In all cases, $a = -3$ for ρ_{tot} (summed over all internal quantum numbers). The parameter b varies somewhat from case to case but is always of order m_π^{-1}; thus the maximum temperature $T_0 = b^{-1} \approx m_\pi$ is predicted in rough agreement with Hagedorn's empirical determination. The inclusion of exotic states has little effect on ρ_{tot} but does redistribute the partial level densities according to a simple rule. The predicted level densities (excluding exotic states) are compared with present data. (auth)

10487 RELATIONS BETWEEN TOTAL CROSS SECTIONS, AVERAGE MULTIPLICITIES, AND THRESHOLD FUNCTIONS. Meggs, William J. (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 7, 2166-9(1 Oct 1971).

Simple recursion relations for the asymptotic behavior of inelastic cross sections are used to derive relations between total cross sections, average multiplicities, and threshold functions. (auth)

10488 EXCLUSIVE LIMIT OF INCLUSIVE PROCESSES. Ball, James S.; Pinsky, Stephen S. (Univ. of Utah, Salt Lake City). Phys. Rev. Lett.; 27: No. 26, 1820-3(27 Dec 1971).

The Mueller expansion of the forward three-body amplitude is used to deduce an expansion for the elastic two-body scattering amplitude at large angles. The first term in the expansion is compared with the data for large-angle elastic pp data, and is found to be in good agreement. Under special circumstances it is found that the ratio of the large-angle elastic differential cross section to the total cross section is a universal function of one variable independent of the process. (auth)

10489 CONNECTION BETWEEN MASS AND ISOSPIN SPECTRA IN LOCAL CURRENT ALGEBRAS. Divakaran, P. P. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 2: No. 22, 1123-6(27 Nov 1971).

The "no-go" theorem of Chang, Dashen, and O'Raifeartaigh [Phys. Rev., 182: 1805, 1819(1969)] states that, in all factorizable $I = \frac{1}{2}$ representations at infinite momentum, either there must be states of imaginary mass or all states must have the same mass. Further progress on deducing hadronic properties from equal-time local current algebras, therefore, depends on the answers to two questions: What physical principles are responsible for this negative result? To what extent must one relax the assumption of $I = \frac{1}{2}$ saturation to avoid similar pitfalls? It is shown that, in all representations of the covariant infinite-momentum algebra of conserved currents that are not composed (e.g., bilinearly) of free fields, the isospin spectrum is unbounded if the mass spectrum in the corresponding finite-momentum representation is physical. This is a corollary of the following theorem for representations of current algebras on H, the physical Hilbert space of states: In all representations on H of the covariant algebra of conserved currents, the isospin spectrum is unbounded if the mass spectrum is physical. This result is an elementary consequence of the Federbush–Johnson theorem [Phys. Rev., 120: 1926(1960)] and, therefore, answers the first question above: the unboundedness of the isospin follows from the interplay of locality (which is implied by the equal-time commutation relations) and a physical energy and mass spectrum. (R.W.R.)

10490 WHAT IS THE CHARGE OF PARTON? Lipkin, H. J. (Argonne National Lab., Ill. National Accelerator Lab., Batavia, Ill.). Phys. Rev. Lett.; 28: No. 1, 63-6(3 Jan 1972).

It is shown that present inclusive electroproduction experiments cannot distinguish the fractionally charged quark model from certain multitriplet models with integral charges, e.g., the Han–Nambu three-triplet model, which contain additional internal degrees of freedom and predict new "charmed" hadron states, which have not yet been observed. Both models are shown to predict identical results if no "charmed" states are produced and very similar results unless charmed particle production appreciably affects the inclusive cross section. (auth)

10491 RESIDUES IN DUAL-RESONANCE MODELS. Oh, C. H. (Univ. of Otago, Dunedin, N. Z.). Lett. Nuovo Cim.; 2: No. 23, 1201-6(4 Dec 1971).

Formulas are derived for computing partial widths for the Veneziano, Mandelstam–Veneziano, and Virasoro models from partial-wave projections for the case of $\pi\pi$ scattering. A relation is then established between the Regge residues and partial widths. (L.B.S.)

10492 FOURIER TRANSFORMS IN THE NONPOLYNOMIAL HARMONIC-OSCILLATOR MODEL. Fels, Stephen B. (Univ. of California, Los Angeles. Univ. of Texas, Austin). Phys. Rev., D; 4: No. 8, 2208-15(15 Oct 1971).

Problems associated with the Lee-Zumino approach to nonpolynomial interactions are shown to exist even after employing their special method for calculating the Fourier transforms of Green's function. (auth)

10493 BOOTSTRAP MODELS AND A SPECIAL PROPERTY OF THE UNITARY LIE ALGEBRAS. II. THE MINIMAL BOOTSTRAP. Yellin, Joel (Yeshiva Univ., New York); Anderson, Carl M. Phys. Rev., D; 4: No. 8, 2476-82(15 Oct 1971).

The following statement is proved: In any of the standard bootstrap frameworks, if one begins with a meson world chosen so that (a) it is symmetric with respect to some simple, compact Lie algebra, L, (b) all particles belong to N-fold degenerate families, each classifiable under the identical representation R, and (c) the discrete quantum numbers are such that both symmetric and antisymmetric trilinear couplings exist, then for a given choice of l (l = the number of mutually commuting conserved charges) the minimal degeneracy turns out to be $N = (l + 1)^2$ and the corresponding minimal representation R = adjoint $\oplus$ singlet of $SU(l + 1)$. (auth)

10494 OFF-SHELL MULTIPERIPHERAL MODEL. Greenman, J. V. (Univ. of Essex, Colchester, Eng.). Phys. Rev., D; 4: No. 8, 2504-15(15 Oct 1971).

An off-shell multiperipheral model for two- and three-body amplitudes derived from field-theory equations providing a unitarization of two- and three-body peripheral graphs is proposed. In particular, it generates a two-body amplitude that satisfies two- and three-body unitarity. The only input in the model is the choice of the two- and three-body peripheral graphs as the driving terms of the integral equations. The energy-analytic method is used to obtain equations which are without relative energy, but still possess most of the desirable properties of the original equations. (auth)

10495 CURRENT ALGEBRA AND UNITARITY. II. Ford, Peter; Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass.). Phys. Rev., D; 4: No. 8, 2402-11(15 Oct 1971).

In earlier work a "unitarized tree approximation" was constructed from an exact representation of $\pi\pi$ scattering satisfying current-algebra constraints, when supplemented by a hypothesis concerning a certain "contact term." A realization of this representation is constructed in the linear σ model so as to examine the validity of this hypothesis, previously justified by intuitive arguments. It is now shown that this hypothesis can be verified in perturbation theory without appeal to these earlier arguments, which lends further support to our unitarization program. (auth)

10496 HADRON BOOTSTRAP HYPOTHESIS. Chew, Geoffrey F. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 8, 2330-5(15 Oct 1971).

A discussion is given of the conjecture that classical space-time properties prescribe a unique S-matrix which approximates strong-interaction phenomena. (auth)

10497 FACTORIZATION OF THE N-PARTICLE INCLUSIVE REACTION IN THE DUAL-RESONANCE MODEL. Hsue, C. S. (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 8, 2336-8(15 Oct 1971).

Using Mueller's approach the N-particle inclusive spectrum of the dual-resonance model was investigated by calculating the residue of the poles in the missing-mass variable. The remaining integration was evaluated by the method of steepest descent. Restriction is made to the multi-Regge region. The resultant N-particle spectrum factorizes into the product of single-particle spectra obtained earlier by several groups. (auth)

10498 DISTRIBUTION OF PARTONS IN A HADRON. Noskowicz, Simon Henri; Susskind, Leonard (Tel-Aviv Univ., Israel). Nucl. Phys.; B36: No. 1, 99-108(1972).

The distribution of partons in the dual model of Nielsen and Susskind is derived and some simple explanations of the relation between Regge behavior, form factors, pion production and the parton distribution are explained in qualitative terms. A possible modification of this distribution is introduced in order to "flatten" the pomeron. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 10576, 10582, and 10592.

10499 (AECD/TP-28) K* BOOTSTRAP USING THE VENEZIANO MODEL. Huq, M. (Atomic Energy Centre, Dacca (Pakistan)). Feb 1971. 14p. Dep. NTIS (U. S. Sales Only).

The K* resonance was bootstrapped using the Veneziano model as input to N/D equations solved by the Balazs method. The results are consistent with FESR duality. (auth)

10500 (DESY-71/45) NUCLEON LOOP AS A FORCE IN THE $\pi\pi$-CHANNEL. Gutbrod, Fritz (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1971. AT(11-1)-1764. 37p. Dep. NTIS.

The ρ-meson is described as a $\pi\pi$-$N\bar{N}$ composite system, with N-exchange as a nondiagonal force between the two channels. The resulting nucleon loop, as a force in the $\pi\pi$-channel, gives far too strong attraction, if calculated with unmodified nucleon propagators. The necessary cut-off parameter in the nucleon propagators is compared with the same quantity obtained in the $\Delta(1236)$-channel. Pion self-energy effects are introduced to improve the resulting ρ-width, and crossing properties of the $\pi\pi$-P-waves are discussed. (auth)

10501 NECESSITY FOR LOW-ENERGY $\pi\pi$ MODELS TO SATISFY THE EXACT RESULTS OF AXIOMATIC FIELD THEORY. Pennington, M. R.; Pond, P. (Westfield Coll., London). Lett. Nuovo Cim.; 2: No. 21, 1086-90(20 Nov 1971).

Three low-energy $\pi\pi$ models are discussed illustrating the fact that the rigorously provable constraints are not satisfied by every reasonable model. It is found that in each of these models the violations of the rigorous results are of the same order of magnitude as the changes caused by unitarizing the s waves so that ignoring these constraints seems highly inconsistent and may lead to erroneous conclusions about the nature of low-energy $\pi\pi$ scattering. (J.F.P.)

10502 RESONANCE STRUCTURE OF THE VENEZIANO MODEL FOR $\bar{p}n \to 3\pi$ AT REST. Gopal, G. P. (Rutherford High Energy Lab., Chilton, Eng.); Migneron, R.; Rothery, A. Phys. Rev., D; 4: No. 7, 2169-72(1 Oct 1971).

The resonance structure contained in the four-point Veneziano amplitude describing $\bar{p}n \to \pi^+\pi^-\pi^-$ at rest is determined. The relative strengths of the resonances are obtained by partial-wave analysis of the amplitude with its imaginary part retained. The ρ, f, and g mesons on the leading trajectory appear to be decoupled, and it is found that the ancestor resonances do not exist. Spin-0 and spin-1 daughters are found to be dominant. (auth)

10503 DETERMINATION OF $\omega-\omega$ COUPLING CONSTANTS FROM A VENEZIANO MODEL AND THE $f \to \omega + \gamma$ DECAY. Levy, Naomi (DESY, Hamburg); Singer, Paul. Phys. Rev., D; 4: No. 7, 2177-9(1 Oct 1971).

A Veneziano model, previously constructed, relates the coupling of f to two vector mesons in terms of the couplings of the particle exchanged in the crossed channels. It is here used to calculate explicitly the coupling of the f meson to two ω mesons, as well as its radiative decay into $\omega + \gamma$. (auth)

10504 THEORY OF LEPTON AND SLOW-PION SCATTERING IN NUCLEAR MATTER. Akhiezer, I. A.; Barts, B. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1166-73(Jul 1971). (In Russian).

The processes of lepton and slow-pion scattering in nuclear matter (NM) are studied in the region of momentum transfer $R^{-1} < q < p_0$ (R is the dimensions of the nucleus, $p_0 \sim 250$ MeV/c is the Fermi cut-off momentum), NM being in this region a good model for describing volume collective oscillations of real nuclei. The processes $\nu \to \mu$, $\nu \to e$, $\mu \to \mu$, $e \to e$, $\gamma \rightleftharpoons \pi^\pm$, $\pi^\pm \rightleftharpoons \pi^0$, $\pi \to \pi$ are considered. General relations between differential cross sections for the processes under consideration are established. Finally, the cross sections for these processes are determined in the Fermi gas model with both strong and electromagnetic interactions between the nucleons of NM taken into account. (auth)

10505 TWO FACES OF A DUAL PION–QUARK MODEL. Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 8, 2398-2401(15 Oct 1971).

One of the new pion models recently constructed by the author is identical to Bardakci's pion sector of the dual quark model. (auth)

10506 ANALYSIS OF THE BEST POSITIVITY AND ANALYTICITY INEQUALITIES ON A GENERAL, CROSSING-SYMMETRIC $\pi^0-\pi^0$ AMPLITUDE. Griss, Martin L. (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 8, 2482-2503(15 Oct 1971).

Inequalities derived previously from rigorous positivity and analyticity for the $\pi^0-\pi^0$ double partial-wave amplitudes (a_{nl}) are reexpressed in terms of Roskies's crossing-symmetric parametrization. Using theorems on moment problems, the "best" inequalities for any value of $\sigma = l + n$ are discussed, and the result is expressed as an allowed region of the otherwise unrestricted parameter space. The $\sigma = 4$ and $\sigma = 5$ "best" inequalities are explicitly calculated and compared with results previously given by Roskies for the case $\sigma = 4$. New inequalities relating the partial-wave amplitudes $f_l(s)$ and their derivatives $f_l'(s)$ are derived, valid for all $l \geq 2$, and all $0 \leq s \leq 1$. They are combined into the general analysis and compared with similar conditions. The moment approach is used to examine the nature of the inequalities resulting from an alternative method due to Roskies and to Piguet and Wanders; the advantages and disadvantages of this approach are discussed. Finally, applications are discussed, to show the constraint that is present in these inequalities. The extension of the method to the case of the $\pi-\pi$ amplitudes with isospin is given in an Appendix. (auth)

10507 COMPLEX POLES IN THE UNITARIZED VENEZIANO MODEL. Scott, David M.; Tanaka, K.; Torgerson, R. (Ohio State Univ., Columbus). Phys. Rev., D; 4: No. 8, 2565-6(15 Oct 1971).

A search was made for complex poles in a unitarized Veneziano model of $\pi\pi$ scattering considered previously. Complex poles in the physical sheet, ghosts, are found in all the s- and p-wave channels, but their effect is physically significant only for the $I = 2$, $l = 0$ channel. (auth)

10508 INCLUSION OF THE PSEUDOSCALAR-MESON OCTET IN THE AMATI–BERTOCCHI–FUBINI–STANGHELLINI–TONIN MULTIPERIPHERAL MODEL. Avalos, Daniel R. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 8, 2352-7(15 Oct 1971).

The multiperipheral model of ABFST is modified to include the exchange of the complete pseudoscalar-meson octet. Assuming only conservation of isospin and hyperchange —i.e., invariance under $SU(2)_I \otimes U(1)_Y$ —one finds that the exchange of kaons and η's increases only slightly the $t = 0$ intercept of the leading output Regge pole. Alternative ways of increasing the strength of the kernel are presented. (auth)

10509 BOOTSTRAP CONDITIONS FROM THE PERIPHERAL MODEL COMBINED WITH DUALITY. Balazs, Louis A. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 8, 2364-73(15 Oct 1971).

By requiring that the $\pi\pi$ absorptive part generated by a peripheral model at moderately high energies be dual (in a semilocal sense) with the Regge behavior in a given process, it is impossible to obtain information on the relevant trajectories. In practice only singly-peripheral graphs are considered, although at higher energies multiperipheral graphs would also come in. The general presentation is therefore in terms of the multiperipheral model, although it does not require any of the usual formal apparatus of this approach. The input graphs are constructed in terms of the $\pi\pi$ amplitude, which is approximated by a Veneziano model. If self-consistency is required between the input and output trajectories, simple algebraic bootstrap conditions on the partial widths of the $\pi\pi$ resonances can be obtained in that model. With the help of an additional duality argument it is also possible to obtain the total width of the g meson. Finally, the total cross section at high energies can be included in the bootstrap by making the Freund-Harari hypothesis, and bodily adding on a Pomeranchuk trajectory.

The results are in reasonably good agreement with experiment. (auth)

10510 RIGOROUS RESULTS OF AXIOMATIC FIELD THEORY APPLIED TO LOW ENERGY $\pi\pi$ SCATTERING. Bonnier, B.; Gauron, P. (CNRS, Paris). Nucl. Phys.; B36: No. 1, 11-27(1972).

Models for low-energy S, P, and D-waves are constructed so as to be in agreement with the rigorous results deduced from analyticity, unitarity and crossing symmetry. The only numerical inputs are the correct mass and width of the ρ meson. The results are in good agreement with experiment, and a well defined σ meson is predicted with a mass $m_\sigma = 700$ MeV and a width $\Gamma_\sigma \simeq 260$ MeV. (auth)

10511 INTERFERENCE EFFECTS IN TWO-RESONANCE SYSTEM. Kopylov, G. I.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 5, 1081-90(Nov 1971). (In Russian).

Interference effects are considered arising in the case when the identical particles with nearly equal velocities exist among the decay products of two resonances. These effects are directly related to the life-time difference of the resonances. (auth)

10512 MESON–MESON SCATTERING. Petersen, J. L. (CERN, Geneva). Phys. Rep.; 2C: No. 3, 155-251(Nov 1971).

A review is presented on present theoretical and phenomenological knowledge of pseudoscalar meson–meson interactions. (296 references) (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 10401 and 10622.

10513 (JINR-P2-6041) RADIATIVE CAPTURE OF PIONS BY HYDROGEN AND THE SIGN OF THE AMPLITUDE OF THE NEUTRAL PION DECAY. Lapidus L. I.; Musakhanov, M. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The process $\pi^- + p \rightarrow n + 2\gamma$ is under consideration. An experimental upper limit was obtained in the Dubna experiment. The neutron kinetic energy W in the reaction is directly connected with effective mass of two gammas with the help of a given relation. Near W = 8,9 MeV one of the photons is soft. In this region the amplitude of the process $M = M_p$ is given by contribution of given diagrams. The Ward–Takachashi identity is used for off-mass shell Compton amplitude in order to demonstrate the gauge invariance of M_p. When calculating the pole contribution it becomes clear that nonpole part is also gauge invariant. It is necessary to take into account a relation in the neutron energy region near W = 0.42 MeV. The total amplitude for the process in the neutron energy region 0 to 8.9 MeV is given. In the laboratory frame of reference it takes the given form. For estimation of relative probability of the process studied the amplitude for another process is taken into account. The functions Φ, (y) are given and y is a ratio of neutron impulse momenta to its maximum value. The signs correspond to signs of $\pi^0 \rightarrow 2\gamma$ amplitude. Three energy regions of the neutron in the studied process are considered separately, I $0 \leq y \leq 0.365$, II $0.4 \leq y \leq 0.06$, III $0.6 \leq y \leq 1$. For these regions relative probabilities are given respectively. It is clear that the result in region I is very sensitive to the sign of $\pi^0 \rightarrow 2\gamma$ amplitude. The amplitude (II) is dominated in region II. In region III the main contribution is given by M_p which is determined with accuracy of order m_π^2/m_p^2. The total ratio of probabilities of process is equal to $(1.94 \pm 0.06)\ 10^{-4}$. The figure is close to the early Baldin's estimation. (auth)

10514 (LBL-33) DUALITY, EXCHANGE DEGENERACY, AND REGGE CUT MODELS IN TWO-BODY COLLISIONS. Field, Richard Dryden Jr. (California Univ., Berkeley. Lawrence Berkeley Lab.). 13 Aug 1971. Contract W-7405-eng-48. 162p. Dep. NTIS.

Thesis.

The discussion covers evidence on duality and exchange degeneracy from finite-energy sum rules for $K^-n \rightarrow \pi^-\Lambda$ and $\pi^+n \rightarrow K^+\Lambda$ interactions, Regge cuts and daughters in pion–nucleon charge-exchange polarization, and Regge–Regge cuts versus daughters in models for $K^-n \rightarrow \pi^-\Lambda$ and $\pi^+n \rightarrow K^+\Lambda$ interactions. (J.F.P.)

10515 (LBL-352) EXPERIMENTAL STATUS OF THE LEADING NON-STRANGE MESON TRAJECTORIES. Gidal, George (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 38p. (CONF-710810-5). Dep. NTIS.

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

A review is given of the current experimental situation regarding the leading nonstrange Regge trajectories. Restriction is made to the gross structure over a large interval of momentum transfer and to those reactions or combinations of reactions which isolate a single leading trajectory in the t channel. The πN reactions are considered. (J.F.P.)

10516 (ORNL-TM-3615) CALCULATIONAL METHOD FOR PREDICTING PARTICLE SPECTRA FROM HIGH-ENERGY NUCLEON AND PION COLLISIONS ($\geq$3 GeV) WITH PROTONS. Gabriel, T. A.; Santoro, R. T.; Barish, J. (Oak Ridge National Lab., Tenn.). 1 Nov 1971. 27p. Dep. NTIS.

A calculational method for predicting the spectra from high-energy nucleon and pion collisions ($\geq$3 GeV) with protons is described. The determination of nucleon–proton and pion–proton total, elastic, and nonelastic cross sections from experimental data is discussed, and procedures for obtaining nucleon and charged-pion spectra from the Ranft–Borak distributions are presented. A brief discussion of the computer program logic is also included. (auth)

10517 PCAC AND SINGLE-PARTICLE DISTRIBUTIONS. Arbab, F. (Univ. del Valle, Cali, Colombia); Gallardo, J. C.; Masperi, L. Lett. Nuovo Cim.; 2: No. 21, 1069-74(20 Nov 1971).

It is shown that by considering the momentum distribution of one pion in certain multiparticle production processes, the PCAC hypothesis alone can be used to relate the zero three-momentum limit of the quantities to other inelastic cross sections for arbitrary incident energy. The relations derived are between unpolarized cross sections integrated over angles. The interactions $K^- + p \rightarrow \overline{K}^0 + p + \pi^-$, $K^- + p \rightarrow \overline{K}^0 + n + \pi^0$, $K^+ + p \rightarrow p(\pi^+) + MM$, $K^- + p \rightarrow p(\pi^+) + MM$, $\pi^- + p \rightarrow p(\pi^+) + MM$, $\pi^+ + p \rightarrow p(\pi^+) + MM$ are considered. (J.F.P.)

10518 PROCESSES $\pi N \rightarrow \omega N$ AT HIGH ENERGIES. Kobylinskii, N. A. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1161-5(Jul 1971). (In Russian).

It is shown that to explain the experimental data for the cross section and density matrix of the process $\pi N \rightarrow \omega N$ at 4.19 GeV it is necessary to take into account not less than four singularities with definite quantum numbers: two with natural and two with unnatural parity. A consideration is made of the model ($\rho + \rho P + B$) describing a number of the available experimental data. A disturbance in the vector dominance model predictions is also noted. (auth)

10519 DUALITY FORMULATION OF THE PARITY-CHANGE RULE FOR BARYONS. Rushbrooke, J. G. (Cambridge Univ., Eng.). Lett. Nuovo Cim.; 2: No. 22, 1131-5 (27 Nov 1971).

The pomeron ($P: I^G = 0^+, J^P = 0^+$) exchange dissociation of a nucleon into a πN final state $A + N \rightarrow A + (\pi N)$, where A is any meson or baryon, is considered. It is shown that a dual description of the dissociation vertex $PN \rightarrow \pi N$ leads simply to the parity-change rule $\Delta P = (-1)^{\Delta J}$. (L.B.S.)

10520 EXOTIC TRAJECTORIES AND THE POMERANCHUKON IN A VENEZIANO REPRESENTATION FOR KN AND $\overline{K}N$ SCATTERING. Desai, Bipin R.; Kumar, Aditya (Univ. of California, Riverside). Phys. Rev., D; 4: No. 7, 2030-47(1 Oct 1971).

The KN and $\overline{K}N$ scattering processes are studied within the framework of the Veneziano model. Apart from the normal trajectories, ρ, Λ, Σ, and Y_1^*, appearing in these processes, for the first time the contribution of the Pomeranchuk trajectory is included in a quantitative manner. An immediate consequence, if one is to avoid exchange degeneracy of the Pomeranchukon, is that baryon trajectories with exotic quantum numbers have to be introduced also. With reasonable parameters for the normal as well as the exotic trajectories, good agreement with a wide range of experimental data for KN and $\overline{K}N$ scattering is obtained. In particular, K^-p and K^+n charge-exchange differential cross sections, K^-p and K^+p elastic scattering in both forward and backward directions, K^-p and K^+p total cross sections, and the polarization parameters for K^-p and K^+p elastic scattering are fitted. The parameters for the best fit imply reasonable properties of the normal as well as the exotic trajectories—the absence of parity partners of $\Lambda(1115)$, $\Lambda_\gamma(1520)$, $\Sigma(1190)$, and $Y_1^*(1385)$, and the correct signature property for the Pomeranchuk trajectory. The normal trajectories come out with a slope of about 1 GeV^{-2}. The slope of the Pomeranchukon, which is the same for the exotic trajectories, is found from the best fits to be about 0.75 GeV^{-2}, while the exotic trajectories have an intercept of about −3.4. The properties of resonances lying on the normal and exotic trajectories are discussed. (auth)

10521 NATURAL- VERSUS UNNATURAL-PARITY EXCHANGE IN FORWARD SCATTERING. Weiner, Richard M. (Indiana Univ., Bloomington). Phys. Rev., D; 4: No. 7, 2174-6(1 Oct 1971).

The assumption of one-particle (pole) exchange at the quark level for $s \to \infty$ leads to the decoupling, in the forward direction, of natural-parity particles (leading Regge trajectories) from octet-decuplet baryonic vertices. In the differential cross section of the reaction $\pi p \to \pi\Delta$ a dip is predicted at $t \simeq 0$, for high s. The study of this dip can lead to an estimate of the upper limit of the quark mass. (auth)

10522 N*(1470)–p TRANSITION FORM FACTOR IN THE CHOU–YANG MODEL. Mickens, R. E. (Fisk Univ., Nashville); Rush, J. E. Jr. Phys. Rev., D; 4: No. 7, 2172-3(1 Oct 1971).

The Chou–Yang model is used in a calculation of the N*(1470)–p M1-transition form factor. (auth)

10523 COULOMB AND MASS-DIFFERENCE CORRECTIONS TO K^-p SCATTERING. Oades, G. C. (Rutherford High Energy Lab., Chilton, Eng.); Rasche, G. Phys. Rev., D; 4: No. 7, 2153-9(1 Oct 1971).

A treatment of low-energy K^-p reactions is presented which includes nonrelativistic electromagnetic mass-difference effects and the effect of the Coulomb potential. It is shown how the corrections to the charge-independent parameters can be calculated in a first-order perturbation treatment. The work extends the usual K-matrix treatment of these corrections by including both inner and outer corrections. Furthermore, these effects are included in the reaction channels as well as in the elastic channel. (auth)

10524 s-CHANNEL ANALYSIS OF πN SCATTERING IN A SCHEME OF HIGHER BARYON COUPLINGS. Ahmed, S. A. S. (Delhi Univ.). Phys. Rev., D; 4: No. 7, 2094-2105(1 Oct 1971).

A relativistic-hadron-coupling scheme recently proposed by Mitra and co-workers is applied to the process $\pi N \to \pi' N'$. This scheme, which is a relativistic extension of an $SU(6) \otimes O_3$ framework of $\bar{B}B_L P$ couplings, is characterized by the appearance of a relativistically invariant form factor, which is endowed with several desirable properties such as Regge universality, crossing symmetry, etc. So far three distinct choices, termed I, II, and III, are available, which satisfy these criteria in varying degrees. The calculation of $\pi N \to \pi' N'$ scattering is done in a pure s-channel model where the various baryon resonances act as the propagators. The effect of other channels (t and/or u) is not considered in the calculation, in the spirit of duality. Specifically, the following processes are considered: (i) the two elastic $\pi^\pm p \to \pi^\pm p$ processes, which have a nonresonant background, and (ii) the $\pi^- p$ charge-exchange process, which does not have such a background. The quantities calculated are the following: $\sigma_T(\pi^\pm p \to \pi^\pm p)$, $\sigma_T(\pi^- p \to \pi^0 n)$, $d\sigma(0)/d\Omega(\pi^- p \to \pi^0 n)$, the polarization P(t) for $\pi^- p$ charge exchange, and the sensitive dimensionless quantity $\mathrm{Im}Kf^{(-)}$. It is found that the above scheme gives a satisfactory account of the data, especially with form factor III, which fits the various details quite accurately. The role of duality in respect of the simulation of the t channel is discussed, especially in relation to the behavior of the quantities $d\sigma(0)/d\Omega$ and $\mathrm{Im}Kf^{(-)}$. (auth)

10525 s-CHANNEL HELICITY CONSERVATION IN $\pi^- p \to \pi^+ N^{+*}$ PROCESSES. Agarwal, B. K.; Seth, V. P. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 2: No. 23, 1174-8(4 Dec 1971).

It is shown by qualitative analysis that near the forward direction the s-channel helicity is conserved in $\pi^- p \to \pi^- N^{*+}$ ($\frac{1}{2}^+$,1400) for which $\Delta J = 0$, but is not conserved in $\pi^- p \to \pi^- N^{*+}$($\frac{3}{2}^-$,1520) for which $\Delta J = 1$. It is suggested that helicity conservation may not be a universal phenomenon for all diffractive process. (L.B.S.)

10526 APPLICATION OF SUBTRACTED FIXED-t DISPERSION RELATIONS TO PION–NUCLEON SCATTERING. Engels, J. (Univ., Bielefeld, Ger.). Nucl. Phys.; B36: No. 1, 73-92(1972).

By application of subtracted fixed-t dispersion relations some implications of analyticity on πN phase-shift analyses are studied. The method consists in varying the subtraction point throughout the phase-shift region and expanding the unknown high-energy contribution in powers of the subtraction energy. As a result one obtains information on both the inaccurately known low-energy region—as an example the S- and P-wave scattering lengths are determined and on energies above the phase-shift region, where a comparison is made to Regge fits. For $-4M < t < 4m_\pi^2$ one can calculate the "subtraction function" $A^{(+)}(\nu = 0, t)$, which is compared with the result from a fixed-ν dispersion relation. (auth)

10527 APPLICABILITY OF THE GLAUBER APPROXIMATION TO NUCLEAR SCATTERING OF PIONS IN THE ENERGY REGION OF THE RESONANCE. Kohmura, Toshitake (CERN, Geneva. Tokyo Univ.). Nucl. Phys.; B36: No. 1, 228-40(1972).

The approximate applicability of the criteria for the Glauber approximation to nuclear scattering of pions in the energy region of the resonance is demonstrated. It is pointed out that the approximation should give a reasonable fit to pion scattering from nuclei in the energy region of the (3,3) resonance, in spite of the strong p-wave interaction between pions and nucleons. Nuclear binding effects on the target nucleons, by suppressing backward scattering of pions from nucleons due to the p-wave interaction, play an important role in making the Glauber approximation valid with a reasonable accuracy. A new formulation of the pion-nucleon scattering amplitude as modified by the effect of nuclear binding on the target nucleon is proposed. This formulation leads to a modified pion-nucleon scattering amplitude which has a resonance energy shifted by 12% and a width narrowed by 12%. The nuclear binding effects confine target nuclei into low-lying states in intermediate states. The locality of the T-matrix for nuclear scattering, which is essential in the Glauber approximation, is shown not to be violated by this freezing of nuclei. The Glauber approximation is related to the optical potential analysis. The freezing gives a basis of the optical-potential analysis. (auth)

10528 APPLICATION OF PHENOMENOLOGICAL QUASI-TWO-BODY MODEL TO $\pi^- p$ INTERACTIONS AT 4 GEV/c WITH STRANGE PARTICLE PRODUCTION. Grishin, V. G.; Inogamov, Sh. V.; Kuznetsov, A. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 5, 1071-80(Nov 1971). (In Russian).

It is shown that the main features of the $\pi^- p$ interactions at 4 GeV/c with strange particle production can be described in terms of a phenomenological quasi-two-body model. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 10763, 11029, and 11044.

10529 (INP–769) TESTS OF THE MODEL OF MULTIPLE DIFFRACTIVE SCATTERING. Czyz, W. (Institute of Nuclear Physics, Krakow (Poland)). Sep 1971. 32p. Dep. NTIS (U. S. Sales Only).

The model of high-energy scattering of composite objects is used to analyze hadron-nucleus and, nucleus-nucleus scattering, and Dirac particle with anomalous magnetic moment scattering from a Coulomb potential. (J.F.P.)

10530 (INR–P–1317) EFFECT OF THE ^{3}He-t-Λ CLUSTER STRUCTURE OF ^{7}Li ON THE ANGULAR DISTRIBUTION IN THE $^7\mathrm{Li} \to {}^4\mathrm{He} + {}^3\mathrm{He} + \pi^-$ DECAY. Chlebowska, Daniela (Institute of Nuclear Research, Warsaw (Poland)). 1971. 7p. Dep. NTIS (U. S. Sales Only).

The angular and energy distributions in the $^7\mathrm{Li} \to {}^4\mathrm{He} + {}^3\mathrm{He} + \pi^-$ decay are calculated with the use of the initial wave function $\phi(^3\mathrm{He} - t - \Lambda)$. The significant sensibility of the angular distribution on the ^{7}Li cluster structure is demonstrated. (auth)

10531 (ITEF–771) MODEL OF THE S-WAVE POTENTIAL WITH A HARD CORE. Gal'pern, E. S.; Lyakhovitskii, V. N.; Narodetskii, I. M.; Simonov, Yu. A.; Ter-Martirosyan, K. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The parameters of the NN static potentials of the form: $V(r) = U_0(\exp(r/b)+C)^{-1}$ $r > r_c$) ∞ $r < r_c$ are found. The values of the parameter C were taken from C = –I (Hulthen potential) to $C = PO_4$ (the values C > I correspond to Woods–Saxon potential). The parameters U_o, r_c and b were found by fitting to pp and np S–wave phase shifts in the energy range $O \leq E_{lab} \lesssim 400$ MeV. The strong dependence χ^2 from the shape of the potential was not found. (auth)

10532 (JINR–P1–6100) ON THE RADIUS OF THE PROTON–PROTON INTERACTION. Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

An expression was obtained for a slope parameter of a diffraction cone by the sum of partial waves. It is shown that the pp-interaction radius is independent of the energy in the range of 1 to 70 GeV. (auth)

10533 (LYCEN–7135) THEORETICAL ANALYSIS OF d(p, 2p)n REACTION BY A POLAR GRAPH. Mithra, B.; Laverriere, R. (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1971. 15p. Dep. NTIS (U. S. Sales Only).

The dispersion theory and a Feynman polar graph were used to study the d(p,2p)n reaction at low energy. The results obtained for the energy dependence of the scattering peak and the normalization factor are in good agreement with the experimental data. (France)

10534 (LYCEN–7153) QUASI-FREE SCATTERING IN DEUTERON BREAK-UP BY DEUTERON. Burq, J. P.; Cabrillat, J. C.; Chemarin, M.; Ille, B.; Nicolai, G. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 9p. Dep. NTIS (U. S. Sales Only).

The quasi-free process was studied in the d(d,dn)p reaction at 27.5 MeV for three angular conditions. The neutron and deuteron were detected in coincidence. The charged particle was identified in a $\Delta E-E$ telescope; the neutron energy was measured by a time of flight method. The experimental results are interpreted using the modified simple impulse approximation (M.S.I.A.). (France)

10535 ABSORPTION CROSS-SECTIONS OF ANTIDEUTERONS ON NUCLEI. Abul-Magd, A. Y. (International Centre for Theoretical Physics, Trieste, Italy); Alberi, G. Lett. Nuovo Cim.; 2: No. 22, 1136-8(27 Nov 1971).

The absorption cross sections of antideuterons of 25 GeV/c on different atomic nuclei from lithium to lead was previously measured. An analysis is made of these data using the Glauber multiple-scattering theory and treating the antideuteron as an elementary particle. (L.B.S.)

10536 FORBIDDEN EMISSION OF SOFT PIONS AT ASYMPTOTIC ENERGY. Lo, S. Y. (Univ. of Glasgow). Lett. Nuovo Cim.; 2: No. 21, 1091-5(20 Nov 1971).

The question of whether there is pion emission from inelastic scattering in the droplet model is considered by examining the process of soft-pion emission in the nucleon–nucleon scattering with the help of PCAC. It is proven that soft-pion emission is forbidden at asymptotic energy at least to the lowest order of the multiple-scattering series in a given equation. (J.F.P.)

10537 VECTOR-MESON CONTRIBUTIONS TO N–N OBEP. Rochleder, E.; Gersten, A.; Green, A. E. S. (Univ. of Florida, Gainesville). Nuovo Cim.; 6B: No. 2, 89-104(11 Dec 1971).

The various forms of one–vector-meson exchange contributions to the N-N interaction which have been used within the Schroedinger–Pauli equation or within a two-particle Dirac equation. These are the Kemmer interaction, the unconstrained four-vector interaction and the Breit–Green interaction. If one postulates that the limit as m goes to zero gives Breit's interaction of electrodynamics, then the 3rd is the appropriate potential. The transition to the coordinate space is discussed for potentials calculated in momentum space and a simpler approximation in coordinate space is given. Generalized or regularized Yukawa functions are found to improve the convergence of the approximations. (auth)

10538 ONE-PION DISTRIBUTION AND THE INCOHERENT-DROPLET MODEL. Chang, Luis Y. (Univ. Central de Venezuela, Caracas). Phys. Rev., D; 4: No. 7, 2137-42(1 Oct 1971).

The incoherent-droplet model is applied to the analysis of the pion distribution in the reaction $p + p \rightarrow \pi +$ anything. Agreement is obtained for the longitudinal distribution at fixed transverse momentum and for the transverse momentum distribution at fixed longitudinal momentum. (auth)

10539 QUARK-MODEL SUM RULES FOR HYPERON–NUCLEON TOTAL CROSS SECTIONS. James, P. B. (Univ. of Missouri, St. Louis); Rawls, John M. Phys. Rev., D; 4: No. 7, 2017-20(1 Oct 1971).

Predictions of hyperon-nucleon total cross sections are made based upon quark-model additivity sum rules. Using various kinematic conditions for performing the quark decomposition, large qualitative differences result in the Σ^-p total cross section predicted at high energies. Data taken in proposed hyperon-beam experiments should be able to differentiate between predictions of the various kinematic schemes. Also, Serpukhov data are used to confront old quark-model sum rules for conventional beams; results are consistent with additivity sum rules taken with the various hadron systems compared at fixed relative velocity. (auth)

10540 S-MATRIX THEORY OF LOW-ENERGY NEUTRON–DEUTERON SCATTERING. Bower, Richard H. J. Princeton, N. J.; Princeton Univ. (1971). 220p. University Microfilms Order No. 71-23,344.

Thesis.

An investigation of the analytic structure shows that the two leading left-hand singularities are amenable to an S-matrix calculation. To calculate the proton exchange contribution only a coupling constant is required, and to calculate the three-nucleon pinch contribution the on-mass-shell nucleon–nucleon amplitude with the three momentum continued to unphysical values is needed. As a subsidiary problem the properties of the nucleon–nucleon amplitude are studied. The singularity due to the two-nucleon–pion pinch is also included. As an accurate knowledge of the distant singularities is not presently available, a cut-off is introduced. The unitarity and analyticity properties of the partial waves are employed to obtain sum rules. These sum rules are used to test the existence of partial wave solutions that for the doublet S-wave have the following properties: the partial wave contains a triton bound state having the experimental triton energy and no other bound states or ghosts; the partial wave has the left-hand discontinuities that are used as input; the partial wave satisfies the unitarity requirements on the right-hand cuts. After establishing the existence of partial-wave solutions, an N/D analysis is performed. The effects of breakup are included by using a simple parameterization (Froissart type) of the inelasticity. The entire doublet S-wave amplitude, including the triton binding energy, the triton coupling constant, and the low-energy experimental phase shift, is produced by adjusting only the distant left-hand singularity structure. For the quartet S wave the experimental low-energy phase shift is produced and found to be very insensitive to the distant left-hand-singularity structure. The quartet solution also contain a ghost, whose position is sensitive to the distant left-hand-singularity structure. (TSS) (Diss. Abstr. Int., B)

10541 MULTIPLICITY GROWTH AND LEADING PARTICLE ENERGY LOSS. Stodolsky, Leo (Stanford Univ., Calif.). Phys. Rev. Lett.; 28: No. 1, 60-3(3 Jan 1972).

The relation between the multiplicity growth and the energy-loss spectrum of an incident particle, as implied by Poisson emission with a classical spectrum, appears to be obeyed experimentally in p + p collisions. (auth)

10542 BOOTSTRAP SUM RULES FOR BARYON–BARYON SCATTERING AMPLITUDES. Fil'kov, L. V.; Grigoryants, A. G. (Lebedev Inst. of Physics, Moscow). Nucl. Phys.; B36: No. 1, 141-54(1972).

"Bootstrap" sum rules were analyzed for NN, $\Xi\Xi$, $\Sigma\Sigma$ and $\Lambda\Lambda$ scattering amplitudes. Coupling constants of the nonstrange mesons with $\frac{1}{2}^+$ baryons were determined. Mass relations $\mu_8^2 \simeq m_{\frac{1}{2}}^2$; $\mu_{\Lambda_1}^2 \simeq m_{\frac{1}{2}}^2$ were obtained. The dependence of pseudoscalar meson-baryon coupling constants on the hypercharge was found. (auth)

10543 PRODUCTION IN THE W-BOSON IN NUCLEON–NUCLEON COLLISIONS. Kunszt, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; B36: No. 1, 301-8(1972).

The cross section for the production of the intermediate vector boson in high-energy nucleon-nucleon collisions is estimated in some of the models proposed for the description of highly inelastic processes. An expression for the total cross section is obtained, which is a smooth function of the c.m. energy and the mass of the W-boson. (auth)

10544 MULTIPERIPHERAL AND POLYPERIPHERAL APPROACHES TO PIONIZATION. Bishari, M. (CERN, Geneva); Horn, D.; Nussinov, S. Nucl. Phys.; B36: No. 1, 109-20(1972).

Introduction of Regge trajectories in addition to the pomeron, which appears in Mueller's approach to pionization, is shown to predict a small dip. The analysis is motivated by a multiperipheral approach. The question whether this approach may lead to an understanding of the peak in the pionic distribution or the asymmetry effect is discussed. A new (polyperipheral) approach based on the exchange of several chains is introduced in order to account for the observed effects. It leads naturally to Mandelstam cuts and is compared with a partonic picture. (auth)

10545 VIRTUAL EXCITATION OF NUCLEON ISOBARS IN NUCLEI AND REACTIONS OF QUASIELASTIC KNOCKOUT OF ISOBARS OF HIGH ENERGIES. Gerasimov, S. J. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 6, 260-2(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6, 385-7(20 Sep 1971).

A new method is proposed for experimentally verifying the existence of isobars in nuclei on the basis of a study of the formation of isobars in reactions where high-energy hadrons interact with nuclei. Starting with the additive quark model it is assumed that the amplitudes for elastic scattering of the hadron by a nucleus and by an isobar in the region of the diffraction peak are approximately equal to each other. Consequences for hadron–deuteron interactions are considered. (J.F.P.)

10546 CALCULATION OF THE π MESON–DEUTERON SCATTERING LENGTH. Kudryavtsev, A. E. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 2, 490-9(Aug 1971). (In Russian).

A formula for the π meson–deuteron scattering length is derived by summation of an infinite series of nonrelativistic Feynman diagrams. The formula is an extension of the Brueckner formula. It is shown that terms corresponding to scattering of nucleons in the intermediate state need not be taken into account. The πd elastic scattering length is -0.06 Fermi. (auth)

10547 DEUTERON–DEUTERON SCATTERING WITH POLARIZED DEUTERONS. Pham Dinh Lien (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A178: No. 2, 375-84(1972). (In French).

The deuteron–deuteron elastic scattering, in the helicity

formalism, is studied for a polarized incident beam. Expressions of the cross section and the polarization are given. A phase-shifts analysis was made in order to obtain phase shifts which fit the cross section as well as the polarization in the lab energy range of 8 to 12 MeV. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 10009, 10415, 10594, and 10632.

10548 (UARAEE–114) WAVE EQUATIONS AND INHOMOGENEOUS GROUPS. Bakri, M. M. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Physics Dept.). 1971. 88p. Dep. NTIS (U. S. Sales Only).

In this review, the realizations of inhomogeneous pseudo-euclidian orthogonal groups are discussed, as a possible enlargement of the Poincaré group. In particular, the irreducible wave equations satisfied by the carrier spaces of the representations of these groups are studied. For a particular class of representations, the wave equations are linear. Two classes are studied in some detail: the massless particles as realizations of the Poincaré group ISO(3,1), and the massive particles as realizations of the inhomogeneous de Sitter group ISO(4,1). The latter is intimately related to the proper time formulation of quantum mechanics, which is discussed in this in some detail. (auth)

10549 LIE ALGEBRAS AND QUASIFIED OPERATORS. Kademova, K. V.; Palev, T. D. (Inst. of Physics, Sofia). Int. J. Theor. Phys.; 3: No. 5, 337-45(Oct 1970).

It is shown that realizations of any Lie algebra by means of bilinear polynomials of quasifield operators exist. These realizations are used to find some class of representations of the algebra. (auth)

10550 EXTENDED LADDER REPRESENTATIONS. Palev, T. D. (Inst. of Physics, Sofia). Int. J. Theor. Phys.; 4: No. 2, 93-9(Apr 1971).

The ladder representations are analyzed from an algebraic point of view. It is found that these representations are closely connected to the representation of the left multiplication of the algebra of all polynomials U/J of the creation and annihilation operators. It turns out that the ladder representations appear as a projection of the left multiplications on a subspace of U/J. The algebraic approach allows one to extend the class of the ladder representations. (auth)

10551 $a^{\pm}$-PARTICLES AND CHIMERON W-MESONS IN HIGH-ENERGY PROCESSES. Pakvasa, S.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Nucl. Phys.; B36: No. 1, 173-90(1972).

(i) The present status of the $a^{\pm}$-particle model of Lee in terms of current data on CP nonconservation and (ii) a chimeron model proposed by Okun in which the $W^{\pm}$-meson of weak interactions is identified with the $a^{\pm}$-particle are reviewed. Properties of the $a^{\pm}$-particles and chimerons are delineated and their relevance to the CP problem, especially in high-energy processes where real production occurs, are discussed. In particular, it is shown that for the chimeron model (ii), "gross" CP violating effects are possible in neutrino-induced W-production processes. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 10390 and 10435.

10552 (SU–4205–256) SYMMETRY BREAKING AND THE PIONIC DECAYS OF K-MESONS. Goswami, D. N. (National Research Council of Canada, Ottawa (Ontario)); Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y. Dept. of Physics). Oct 1971. 21p. (NYO–3399–256). Dep. NTIS.

Symmetry breaking corrections to the current algebra formulas for $K \to 2\pi$ and $K \to 3\pi$ decays are calculated in the framework of a general form of the linear SU(3) σ-model. (auth)

10553 (SU–4205–257) POSSIBLE ORIGIN FOR SYMMETRY BREAKING. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y. Dept. of Physics). Nov 1971. 8p. (NYO–3399–257). Dep. NTIS.

It is conjectured that the total Lagrangian of strong, electromagnetic and weak interactions is invariant under the "left-handed SU(2)" of the weak currents, which is however spontaneously broken. Then a formula is derived for the "tadpole" part of the K-meson electromagnetic mass splitting, which appears to be in reasonable agreement with experiment. (auth)

10554 SUM RULE FOR e^+-e^- ANNIHILATION AND U(3) × U(3) SYMMETRY BREAKING. Lai, C. S. (Univ. of Prince Edward Island, Can.); Lo, S. Y. J. Phys., A (London); 4: No. 6, 859-67(Nov 1971).

It is argued that the difference between the production cross section for T = 0, and T = 1 hadronic final states is related to the U(3) ⊗ U(3) symmetry breaking. A simple sum rule is derived. Various symmetry breaking models are discussed. It is found that results from saturation of the sum rule with vector mesons favor the previously obtained values $b = c \simeq -1$ for the U(3) ⊗ U(3) symmetry breaking parameters. (auth)

Applications (Strong)

Refer also to abstract 10493.

10555 Σ-TERM AND THE SCALE BREAKING. Parisi, G. (CNEN, Frascati, Italy); Testa, M. Lett. Nuovo Cim.; 2: No. 22, 1154-6(27 Nov 1971).

Some consequences of a scale invariance breaking pattern in the framework a simple σ-model are examined. The Σ-term is evaluated. (L.B.S.)

10556 IS SU(3) × SU(3) REALIZED WITH GOLDSTONE BOSONS. Olshansky, R. (Brown Univ., Providence). Phys. Rev., D; 4: No. 8, 2440-6(15 Oct 1971).

The linear σ model is used to study how full chiral symmetry is realized as the $(3,3^*) + (3^*,3)$ intersection is turned off. The Lagrangian which fits the observed spin-zero mass spectrum chooses either a normal realization with degenerate SU(3) × SU(3) multiplets or a Goldstone realization with an octet of massless pseudoscalar mesons, depending on whether the mass term of the Lagrangian is greater or less than a certain critical value. The value of the mass term depends sensitively on the masses of the I = 0 scalar resonances and present knowledge of these masses is compatible with either type of realization. However, the values of the nucleon σ commutators calculated from meson-nucleon scattering data can resolve this issue. For the normal solution the π-N σ commutator is predicted to be about 75 MeV, whereas for the Goldstone solution the prediction is 30 MeV. The symmetry-breaking parameters are $a = -0.91$ and $b = -0.16$ independent of how full symmetry is achieved. (auth)

Field Theories

General

Refer also to abstract 11013.

10557 (JINR–P2–6070) ESSENTIALLY NONLINEAR SCALAR FIELDS AND THE SPACE–TIME GEOMETRY. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

Deformation of the space–time in the essentially nonlinear fields is investigated. The problem of determining the metrics in the field with the given Lagrangian is discussed. It is shown that, in case when the Lagrangian is somehow known beforehand, the measurement of the signal velocity in the given field allows the theory predictions to be checked. Another interesting consequence of the space–time deformation is considered, viz. interaction of all the fields with the given essentially nonlinear field. (auth)

10558 SOLUTIONS OF THE COUPLED EINSTEIN–MAXWELL EQUATIONS REPRESENTING THE FIELDS OF SPINNING SOURCES. Perjes, Zoltan (Central Research Inst. for Physics, Budapest). Phys. Rev. Lett; 27: No. 24, 1668-70(13 Dec 1971).

A wide class of exact solutions of the stationary Einstein–Maxwell equations characterized by a flat "background" three-space is obtained. The solutions can be interpreted as the external gravitational and electromagnetic fields of one or more spinning sources with unit specific charge in stationary configuration. (auth)

10559 NEW INVARIANT FOR ELECTROMAGNETIC FIELDS IN CURVED SPACE–TIME. Prasanna, A. R. (MATSCIENCE, Madras). Phys. Lett.; 37A: No. 4, 331-2(6 Dec 1971).

An invariant $S = R_{hijk} F^{hi} F^{jk}$ for electromagnetic fields in curved space-time is defined and it is further shown that a necessary and sufficient condition that a conformally flat space-time may represent a null electromagnetic field is that S = 0. (auth)

Quantum Field Theory

Refer also to abstracts 10412, 10446, 10447, 10450, and 10548.

10560 (CONF-710637-4) SMALL-DISTANCE BEHAVIOUR ANALYSIS AND WILSON EXPANSIONS. Symanzik, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). 1971. 13p. (IC-71/137). Dep. NTIS (U. S. Sales Only).

From Seminar on electromagnetic interactions; Trieste, Italy (21 Jun 1971).

The small-distance behavior is analyzed considering the theory of one hermitian scalar field. The technique described applies to all renormalizable theories. It is noted that quantum electrodynamics goes completely parallel. (J.F.P.)

10561 (FRNC-TH-119) STUDY OF THE CONVERGENCE FUNCTION IN QUANTUM FIELD THEORY MODELS AND APPLICATIONS TO STRONG INTERACTIONS. Bourrely, Claude (Aix-Marseilles Univ. (France). Faculte des Sciences). 1970. 118p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A canonical convergence procedure was established in order to determine, in a nonarbitrary way, a convergence function when either an approximation to the interaction or a wave function is known for the system. The procedure was tested in the framework of the fixed source model by calculating a source function for the nucleon in the Chew and Low model. The validity of the treatment was examined for $\pi-N$ P-wave scattering with this model. In connection with the divergence problem, an $N-\bar{N}$ compound model was considered, with an interaction which is part of a Fermi hamiltonian in which a convergence function is introduced. This function was chosen in such a way that the model would be soluble (diagonalization of the hamiltonian) and so that the field operators describing the particles would satisfy the conventional commutation relations for $N-\bar{N}$ scattering. The relations between the form factors and the convergence functions were also studied. (France)

10562 (IYAF-60-70) EXPERIMENT ON TWO-QUANTUM ANNIHILATION IN VEPP-2. Balakin, V. E.; Budker, G. I.; Pakhtusova, E. V.; Sidorov, V. A.; Skrinskii, A. N.; Tumaikin, G. M.; Khabakhpashev, A. G. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

Two-quantum annihilation of electron-positron pairs was investigated for total energy $2E = 1$ GeV and at large angles of emission of γ quanta. At the same time elastically scattered electrons are recorded by the same equipment. From a comparison of the measured ratio of the number of γ quanta to the number of electrons with a calculated value, there was obtained a constraint on the limits of applicability of quantum electrodynamics $\Lambda > 1.3$ GeV. (tr-auth)

10563 (JINR-P2-6109) PRINCIPLES OF QUANTUM THEORY OF SPINOR FIELD IN RIEMANNIAN SPACE-TIME. Chernikov, N. A.; Shavokhina, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 35p. (In Russian). Dep. NTIS (U. S. Sales Only).

The basic statements of the quantum spinor field theory in the Riemannian space-time are formulated which allow the effect of the nonquantized gravitational field on the behavior of the quantized spinor field to be taken into account. (auth)

10564 (LA-tr-71-80) VACUUM POLARIZATION IN MUONIC ATOMS. Fricke, B. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Phys.; 218: 495-508(1969). 18p. Dep. NTIS.

The topics discussed are vacuum polarization of order α, the charge distribution of the polarization cloud, further corrections in the first order in α, vacuum polarization of order α^2, and vacuum polarization of order α^3. Muonic uranium-238 atoms are considered. (J.F.P.)

10565 (NYO-4076-20) INTRODUCTION TO THE CHARACTERISTIC INITIAL VALUE PROBLEM IN QUANTUM FIELD THEORY. Domokos, G. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Aug 1971. Contract AT(30-1)-4076. 28p. Dep. NTIS.

The lectures on the initial value problem cover intuitive considerations, the elementary theory of characteristics, kinematics and the spinor technique, some elementary properties of the characteristic initial value problem and the physical interpretation, and the lightlike quark model. (J.F.P.)

10566 (ORO-3992-72) ON THE STRUCTURE OF RELATIVITY GROUPS. Lugiato, Luigi A.; Gorini, Vittorio (Texas Univ., Austin. Center for Particle Theory). Dec 1971. 22p. (CPT-125). Dep. NTIS.

An attempt is made to define the class of equivalent reference frames in special relativity in terms of a purely kinematical characterization of the notion of free material point and using homogeneity of space and time, isotropy of space and unidirectional time flow. The problem of finding the possible forms of the relativity group and the significance of a "space-time homogeneity axiom" which was used previously are discussed. (auth)

10567 (UARAEE-116) CANONICAL PROPER-TIME FORMALISM. Bakri, M. M. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Physics Dept.). 1971. 8p. Dep. NTIS (U. S. Sales Only).

A five-dimensional canonical formalism is developed, in which the fifth component of the coordinates is the proper time, and the corresponding component of the momentum is the mass. The proper-time formalism, postulated previously is derived self-consistently. (auth)

10568 GAUGE PROBLEM IN QUANTUM FIELD THEORY. Han, M. Y.; Biedenharn, L. C. (Duke Univ., Durham, N. C.). Lett. Nuovo Cim.; 2: No. 21, 1110-15(20 Nov 1971).

It is shown that previous work in which it is asserted that there exists no nontrivial four-vector A_μ other than $A_\mu = \partial_\mu \phi$, where ϕ is a scalar field, is incorrect. (J.F.P.)

10569 HIGH-ENERGY BEHAVIOR OF LADDER GRAPHS WITH MULTIPLE LOOPS. Horvath, Z.; Pocsik, G. (Roland Eoetvoes Univ., Budapest). Lett. Nuovo Cim.; 2: No. 22, 1146-8(27 Nov 1971).

The high-energy limit of the sum of ladder graphs is considered where the individual rungs consist of multiple bubbles corresponding to the interaction Lagrangian for a neutral scalar field. It is shown that, in the self-interacting power-type model at high-energy, a simple coupling-constant renormalization removes the ultraviolet infinities from the sum of ladders; a finite Regge-pole term and weak oscillations remain as the leading-order behavior of the complete amplitude. (L.B.S.)

10570 RELATIVISTIC DYNAMICS WITH NONCANONICAL POSITIONS. Peres, Asher (Technion-Israel Inst. of Tech., Haifa). Phys. Rev. Lett; 27: No. 24, 1666-8(13 Dec 1971).

For any Hamiltonian H having vanishing Poisson brackets with the total momentum $\vec{P}$ and angular momentum $\vec{J}$, it is always possible to construct boost operators $\vec{K}$ having the correct Poisson brackets with all the other generators of the Poincaré group. Thus the existence of dynamical variables satisfying the algebra of the Poincaré group generators is not in itself a guarantee of Lorentz invariance. (auth)

10571 SCALING, LIGHT-CONE EXPANSION, AND THE VAN HOVE MODEL. Bander, Myron (Univ. of California, Irvine). Phys. Rev., D; 4: No. 4, 1237-9(15 Aug 1971).

With certain assumptions on the coupling of two currents to particles of increasing spin, it is shown that the Van Hove model results in Bjorken scaling and Regge asymptotic behavior. The fields corresponding to these particles are related to the products appearing in the operator-product expansion near the light cone. (auth)

10572 ASYMPTOTIC BEHAVIOR OF SPECTRAL FUNCTIONS AND SINGULARITIES OF WIGHTMAN FUNCTIONS AND FIELD COMMUTATORS. Kaschluhn, F. (Univ., Berlin); Wieczorek, E. Ann. Phys. (Leipzig); 27: No. 3, 316-18(1971).

Singularities of Wightman functions and field commutators are studied in localizable and nonlocalizable cases including the spectral behavior of $\sigma(q^2) = \exp(\alpha q^2)$, $\alpha > 0$. (auth)

10573 LINEARITY IN THE SPECIAL THEORY OF RELATIVITY. Dutta, M. (Univ. of Calcutta); Mukherjee, T. K.; Sen, M. K. Int. J. Theor. Phys.; 3: No. 2, 85-91(Apr 1970).

In deductions of Lorentz transformations of the special theory of relativity, linearity of transformation is always postulated. There are only a few discussions about this linearity in which it is deduced from some basic physical facts. It is shown to be almost a mathematical consequence of the principle of relativity. (auth)

10574 PRINCIPLE OF TEMPERATE ACTION AND A NEW TYPE OF UNCERTAINTY RELATION. Rayski, Jerzy (Jagellonian Univ., Krakow). Int. J. Theor. Phys.; 3: No. 4, 307-14 (Aug 1970).

A new physical principle, called principle of temperate action, is introduced to secure the convergence of the theory of quantized fields. In order to satisfy this principle, as well as the correspondence requirements, a dimensional constant a must be incorporated into the Lagrangian, which becomes bounded or increasing sufficiently slowly for its arguments tending to infinity. In some cases of temperate actions there appear constraints introducing nonlocal features and/or uncertainties of the order of magnitude of the constant a, in spite of the fact that the Lagrangians are local. (auth)

10575 CLASSICAL SPIN-½ TACHYON FIELD. Marx, Egon (Drexel Univ., Philadelphia). Int. J. Theor. Phys.; 3: No. 4, 299-305(Aug 1970).

The classical theory is presented of a set of two spinor fields patterned closely after the Dirac theory in two-component form, but each field obeys a modified Klein–Gordon equation, in which the sign of m^2 has been changed. The solution contains parts with real and imaginary frequencies, that contribute differently to conserved quantities such as the charge and the energy-momentum vector. It is also shown how the minimal interaction with the electromagnetic field is obtained. (auth)

10576 MASS AND TOTAL DECAY RATE OF UNSTABLE PARTICLES IN QUANTUM FIELD THEORY. Ram, Michael (State Univ. of New York, Buffalo). Int. J. Theor. Phys.; 3: No. 2, 153-64(Apr 1970).

A very simple expression is derived for the total decay rate of an unstable particle analogous to the optical theorem, and its equivalence with the total decay rate defined in terms of the imaginary part of the propagator pole is demonstrated. The common origin of mass shifting and total decay rate is also demonstrated. (auth)

10577 REMARKS ON UNIFIED FIELD STRUCTURES, SPIN STRUCTURES, AND CANONICAL QUANTIZATION. Hurt, Norman E. (Univ. of Massachusetts, Amherst). Int. J. Theor. Phys.; 3: No. 4, 289-94(Aug 1970).

Unified field structures are defined and reviewed. Under certain conditions these are shown to be dynamical systems. And quantizable dynamical systems are shown to be unified field structures with invariant Riemannian metric. Spin structure is reviewed and manifolds M^{8k+4} with spin structure are shown to be symplectic. (auth)

10578 POWER SERIES OF THE FREE FIELD AS OPERATOR-VALUED FUNCTIONALS ON SPACES OF TYPE S. Rieckers, A. (Univ., Tuebingen, Ger.). Int. J. Theor. Phys.; 4: No. 1, 55-82 (Feb 1971).

Infinite series of Wick powers of the free, massive Bose field are analyzed in terms of test function spaces of type S for arbitrary space dimension. By direct estimates of the smeared phase space integrals sufficiency conditions for the existence of the vacuum expectation values are derived. These conditions are shown to be precise. The field operators are defined on a dense invariant domain in Fock space, where they satisfy the Wightman axioms with the possible exception of locality. Localizable and non-localizable fields are dealt within the same frame. The behavior of spectral functions and the strength of singularities are discussed. (auth)

10579 GEOMETRIC STRUCTURE OF A PARITY-CONSERVING RELATIVISTIC QUANTUM FIELD THEORY. Westenholz, C. v. (Rhodes Univ., Grahamstown, South Africa). Int. J. Theor. Phys.; 4: No. 4, 305-20(Aug 1971).

Wheeler's conjecture that there might exist a "principle" which rules out parity-nonconserving spaces is analyzed. The following result was obtained: A local relativistic quantum field theory is parity-conserving if the following conditions hold: the fields are derived from geometry, i.e., they are represented by quantized currents (in the sense of de Rham); and the theory may be defined on a connected and, under certain restrictions, on a disconnected orientable space-time continuum M^4. (auth)

10580 FUNCTIONAL QUANTUM THEORY OF FREE RELATIVISTIC SCALAR FIELDS. Bauhoff, W. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 26a: No. 9, 1553-8(Sep 1971).

Dynamics of quantum field theory can be formulated by functional equations. Starting with the Schwinger functionals of the free scalar field, functional equations and corresponding many-particle functionals are derived. To establish a complete functional quantum theory, a scalar product in functional space has to be defined as an isometric mapping of physical Hilbert space into the functional space. (auth)

10581 SPACE–TIME STRUCTURE AND MEASUREMENT THEORY. Antoine, J.-P. (Univ. of Pittsburgh); Gleit, Alan. Int. J. Theor. Phys.; 4: No. 3, 197-216(May 1971).

Naive operational approach to measurement theory is given in a truly relativistic framework. Both experiments and states exist in finite regions of space-time. The causality structure of the underlying Minkowski space is described in terms of these. (auth)

10582 REGGE-POLE CONTENT OF CHIRAL AND GAUGE FIELD THEORIES. Dicus, Duane A.; Freedman, Daniel Z.; Teplitz, Vigdor L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 8, 2320-30(15 Oct 1971).

The high-energy limits of the 4-pion and 6-pion tree-approximation amplitudes in the nonlinear chiral-invariant Lagrangian and of the $\rho-\rho$ scattering amplitude in massive Yang-Mills theory are investigated in order to see whether Reggeization of elementary particles occurs. It is found that the 4- and 6-pion amplitudes are dominated asymptotically by exchange of Regge poles with quantum numbers of the ρ and A_1 mesons, respectively. These trajectories are regarded as "ancestors," because ρ and A_1 particles are not present in the initial Lagrangian. The $\rho-\rho$ scattering amplitude is dominated by the exchange of quantum numbers of the ρ meson, but there are two trajectories present, so that Reggeization does not occur. Nevertheless, in all amplitudes computed there is a striking regularity in the dominance of high-energy limits by the exchange of quantum numbers of the ρ and A_1 mesons. (auth)

10583 GAUGE FIELD THEORY OF PARTICLES. I. BOSONS. Cooper, Fred (Yeshiva Univ., New York); Chodos, Alan. Phys. Rev., D; 4: No. 8, 2374-92(15 Oct 1971).

It is suggested that it is a reasonable approximation to consider the bosons and fermions found in nature as the normal modes of an underlying field theory which is invariant under gauge transformations of the second kind. The field theories for the boson and fermion "trajectories" contain an infinite number of fields with bilinear interactions between nearest neighbors in the index space of the finite-dimensional $(\frac{1}{2}k,\frac{1}{2}k)$ representations of the Lorentz group. When the electromagnetic field is turned on, it is found that the physical particles have form factors. The connection between the bare masses of the underlying fields and the masses and form factors of the physical particles is discussed. It is shown how to choose the bare masses so that the physical particles lie on asymptotically linearly rising Regge trajectories. The space is expanded to include isospin and trajectory normality, and a Lagrangian is constructed which contains both the π and ρ trajectories. From this Lagrangian, the vector and axial-vector currents are found, and it is shown that these currents obey the chiral $SU(2) \otimes SU(2)$ algebra. By postulating that scattering is the absorption and emission of external quanta by the underlying fields, and that the external ρ and π mesons couple to the underlying fields via the vector and axial-vector currents, rules can be given for calculating, in the narrow-resonance approximation (only tree diagrams), any N-point function, where all but two of the external legs are π, ρ, or A_1 mesons. Calculations can also be made of any particle + current → particle + current amplitude in that approximation. (auth)

10584 GENERALIZED COHERENT STATES. Stoler, David (Polytechnic Inst. of Brooklyn). Phys. Rev., D; 4: No. 8, 2309-12(15 Oct 1971).

Using an operator technique, the generalized coherent states which were introduced by Titulaer and Glauber and discussed recently by Bialynicka-Birula are discussed. Using this technique, an alternative derivation of the most general coherent state is provided and then a number of interesting properties is derived some of which do not seem to be in the literature. For example, it is shown that the generalized coherent states are not minimum-uncertainty packets. (auth)

10585 NORMAL-PRODUCT QUANTIZATION OF CURRENTS IN LAGRANGIAN FIELD THEORY. Lowenstein, J. H. (Univ. of Pittsburgh). Phys. Rev., D; 4: No. 8, 2281-90(15 Oct 1971).

Techniques for quantizing currents in Lagrangian field theory are developed with the aid of Zimmermann's normal products. These methods greatly simplify the derivation of single-current generalized Ward identities and may be used to justify the heuristic use of formal arguments in discussing broken symmetries. Applications to the energy-momentum tensor in the A^4 model and to the current of broken orthogonal symmetry in a two-component scalar model are presented. (auth)

10586 NEW INCONSISTENCIES IN THE QUANTIZATION OF SPIN-$\frac{3}{2}$ FIELDS. Hagen, C. R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 8, 2204-8(15 Oct 1971).

The possibility of consistently quantizing a spin-$\frac{3}{2}$ field in the presence of a coupling to a scalar and a spinor field is considered. It is found that, contrary to a recent assertion, the anticommutators of the various Fermi-Dirac fields are not positive definite. Inasmuch as this inconsistency is found to be present for the case in which the $\frac{3}{2}$ field participates only linearly in the interaction, such a result demonstrates that the difficulties discovered by Johnson and Sudarshan for an electromagnetic coupling can be expected to occur for a considerably more general class of interactions. (auth)

10587 FEYNMAN RULES FOR THE YANG–MILLS FIELD: A CANONICAL QUANTIZATION APPROACH. III. Mohapatra, Rabindra Nath (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 8, 2215-20(15 Oct 1971).

The canonical quantization procedure was applied to the Yang-Mills field in axial gauge ($\vec{b}_3 = 0$). Noncovariant Feynman rules to all orders with any number of loops are obtained. It is then shown that the tree diagrams to all orders and the one-loop diagram to lowest order can be made covariant. The fictitious scalar particle makes its appearance in the covariantized one-loop diagram. (auth)

10588 CONVARIANCE AND THE FEYNMAN RULES OF A MASSIVE GAUGE THEORY. Finkelstein, Robert J.; Kvitky, Joel S.; Mouton, John O. (Univ. of California, Los Angeles). Phys. Rev., D; 4: No. 8, 2220-9(15 Oct 1971).

If the interaction Lagrangian contains derivatives, or if the spins of the interacting particles ≥ 1, then both the propagators and the interaction Hamiltonian contain normal-dependent terms. Lee and Yang showed that if the noncovariant part of the propagator is dropped, then the finite interaction Hamiltonian is modified. In addition, there appears a term that is divergent, anti-Hermitian, and generally noncovariant if it does not vanish, namely, $\delta H = \frac{1}{2}i\hbar\delta^4(0) \times \ln \det g$, where g depends on the structure of the theory. For massive gauge theories it is shown that $\delta H = 0$ and that $H_{int} = -L_{int}$. These theories are manifestly covariant and the ordinary Feynman rules hold. Renormalization is not discussed. (auth)

10589 BEHAVIOR OF COMMUTATOR MATRIX ELEMENTS AT SMALL DISTANCES. III. SUM RULES FOR FORM FACTORS AND THEIR DERIVATIVES AT t = 0. Voelkel, A. H. (Freie Univ., Berlin). Phys. Rev., D; 4: No. 8, 2229-42(15 Oct 1971).

From general principles of quantum field theory (especially locality and Poincaré invariance), the small-distance behavior of commutator matrix elements, and partial conservation of axial-vector current (smoothness of the matrix elements in the meson masses), sum rules between the four weak isovector form factors and their first derivatives at zero momentum transfer are derived. (auth)

10590 ANALYTICITY, COVARIANCE, AND UNITARITY IN INDEFINITE-METRIC QUANTUM FIELD THEORIES. Gleeson, A. M.; Moore, R. J.; Rechenberg, H.; Sudarshan, E. C. G. (Univ. of Texas, Austin). Phys. Rev., D; 4: No. 8, 2242-54(15 Oct 1971).

The general properties of analyticity, covariance, and unitarity are studied in quantum field theories regularized by finite-mass, indefinite-norm states. After reviewing the general status of indefinite-metric theories, a relativistic scalar model is analyzed for covariance and analyticity. This model shows that a commonly accepted prescription for treating the negative-norm states is not covariant, and more sophisticated methods are required. The technique of shadow states developed elsewhere is reviewed and applied to this problem. (auth)

10591 ANOMALIES OF THE AXIAL-VECTOR CURRENTS IN A THIRRING MODEL WITH INTERNAL SYMMETRY. Georgi, Howard (Yale Univ., New Haven). Phys. Rev., D; 4: No. 8, 2254-9(15 Oct 1971).

A two-dimensional field theory is considered which is a generalization of the Thirring model to include SU(2) symmetry, and the properties of the isospin currents are investigated in this theory. The anomalous divergences of the axial-vector currents are calculated using functional methods. The results agree with those obtained by Hagen using nonperturbative techniques. The anomalies are found to have the form suggested by a dynamical theory of currents in two dimensions. (auth)

10592 CHIRAL MULTI-LOOPS. Honerkamp, J. (CERN, Geneva). Nucl. Phys.; B36: No. 1, 130-40(1972).

With help of functional integral methods a complete perturbation series for a nonlinear chiral Lagrangian is given, in which each term, corresponding to a class of graphs with a definite number of internal loops and a definite topological structure, is chiral invariant. (auth)

10593 CONNECTION BETWEEN YANG–MILLS FIELDS AND DUAL MODELS. Neveu, A.; Scherk, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B36: No. 1, 155-61(1972).

A particular low-energy limit of dual models, where the intercept of the leading trajectory is fixed at one, while the slope goes to zero is investigated. In this limit, only the π and ρ remain, and they are coupled among themselves through the Lagrangian of the massless Yang–Mills theory. (auth)

10594 SU(3) x SU(3) SYMMETRY BREAKING IN A SIMPLE MODEL. De Wit, B. (Univ., Utrecht). Nucl. Phys.; B36: No. 1, 205-27(1972).

A field-theoretical model, due to Lévy, is studied. It contains a triplet of quarks and a pseudoscalar and a scalar meson nonet. The original SU(3) × SU(3) symmetry is broken by terms linear in the scalar meson fields. A renormalization and regularization procedure is defined in order to remove the ultraviolet divergences. The possibility of a spontaneous breakdown of the symmetry is described and the Goldstone theorem is verified in the one-loop approximation. Moreover, the Ademollo–Gatto theorem is reproduced. The axial vector coupling constants differ in first order of the SU(3) symmetry breaking. (auth)

Gravitation and General Relativity

Refer also to abstracts 10010 and 10445.

10595 (IC–71/144) TOPICAL MEETING ON GRAVITATION AND FIELD THEORY, 13–16 JULY 1971 (SUMMARIES). (International Centre for Theoretical Physics, Trieste (Italy)). Nov 1971. 45p. Dep. NTIS (U. S. Sales Only).

Summaries of research are presented on quantum gravitation, the dynamics of gravitation, covariant quantum geometrodynamics, the method of Faddeev and Popov, infinity suppression in gravity-modified electrodynamics, f–g theory, massive gravitation and its massless limit, properties of f–g theory in the case $g = \eta$, and the constraint relation in two-tensor gravity. Also treated are alternative two-tensor theory, the classical two-graviton project, Lorentz-covariant Lagrangians and causality, radiation, energy, and the BMS group, representations of the BMS group, some recent developments, N–P constraints, singularities in general relativity, elementary particles in cosmology, quantum cosmology, flat-space model for black holes, and the field equations of gravitation. (J.F.P.)

10596 (JINR–P2-6094) STOCHASTIC SPACES. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 32p. (In Russian). Dep. NTIS (U. S. Sales Only).

A sketch of theory of stochastic spaces is presented. The definition of the stochastic space is given; some special cases are considered: nonlinear fields and stochastic spaces; stochastic spaces resulting from approximate solving of the field equations in a random medium; stochastic spaces due to the turbulent gravitation or due to the quantum fluctuations of the gravitation. (auth)

10597 FOCUSING OF GRAVITATIONAL RADIATION BY INTERIOR GRAVITATIONAL FIELDS. Lawrence, J. K. (Univ., Vienna). Nuovo Cim.; 6B: No. 2, 225-35(11 Dec 1971).

The deflection of rays of gravitational radiation passing through the interior of a diffuse, static, spherically symmetric distribution of matter is examined along with the focusing of the radiation by this process. Rays passing very near the center of the distribution are the most strongly focused and meet the optical axis near a fixed "focal point." It is found, in general, that sources of a given strength must lie within a particular region of space in order for their radiation to have a given threshold intensity near the focal point. For geometrical point sources, the volume of this region is infinite, but for sources with a non-zero radius it becomes finite and depends on the radius. By estimating the volume needed to explain the frequency of detection of pulses of gravitational radiation by Weber, an upper limit can be put on the size of the sources if the focusing mechanism is to be significant. The resulting size is too small to correspond to any reasonable physical process. (auth)

10598 SPINOR SOLUTIONS TO THE SCHWARZSCHILD METRIC. Oliveira, C. G.; Teixeira, A. F. da F.; Arbex, N. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nuovo Cim.; 6B: No. 2, 214-24(11 Dec 1971).

The class of solutions represented by Hermitian two-by-two matrices associated to time-dependent metrics which correspond to a symmetry Euclidian Killing vector is derived. The elements of this class are related by means of point-dependent unitary unimodular two-by-two matrices. It is shown that these spinor fields associated to the Schwarzschild metric are solutions of the gravitational spinor equations proposed by Sachs. The properties of covariance of the formalism under the transformations of the group SU_2 are analyzed. (auth)

10599 GENERALIZED FIELD EQUATIONS AND THE BRANS–DICKE THEORY. Tupper, B. O. J. (Univ. of New Brunswick, Fredericton). Nuovo Cim.; 6B: No. 2, 105-10(11 Dec 1971).

Generalized field equations of general relativity formed from a set of tetrad vectors are written down for a scalar-dependent tetrad. The resulting equations are identical with the field equations of a particular case of the Brans–Dicke theory. (auth)

10600 SPHERES WITH VARYING DENSITY IN GENERAL RELATIVITY. Durgapal, M. C.; Gehlot, G. L. (Univ. of Jodhpur, India). J. Phys., A (London); 4: No. 6, 749-55(Nov 1971).

Exact internal solutions for massive spheres with three different distributions of density were found. The central core density is considered to be constant while the outer region has two types of varying densities: varying inversely as the square of the radial distance; varying parabolically as $\rho \propto -r^2/\text{constant}$. The solutions are found to be continuous at different boundaries while the densities of different regions are not continuous but vary slightly. With proper choice of different parameters appearing in the solutions, the results can be applied to actual problems of stellar physics. (auth)

10601 SPECIAL QUADRATIC FIRST INTEGRALS OF GEODESICS. Collinson, C. D. (Univ. of Hull, Eng.). J. Phys., A (London); 4: No. 6, 756-60(Nov 1971).

The first set of integrability conditions for the existence of a quadratic first integral of the geodesic equations in a general Riemannian space are obtained. A class of special quadratic first integrals is defined and their properties discussed. (auth)

10602 GRAVITATIONAL CORRECTION TO THE WEAK INTERACTION. Novello, Mario (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 16: No. 18, 269-76(1971).

By means of the operator of the evolution of the Clifford algebra set up in a previous work, it is shown that there is an interaction between spinor fields that assumes the form of the V−A leptonic weak interaction in the flat space case. Some comments about the possible effect of cosmology on leptonic weak interactions are set up. (auth)

10603 GRAVITATIONAL AND INERTIAL MASS OF BODIES OF INTERACTING ELECTRICAL CHARGES. Nordtvedt, K. Jr. (Montana State Univ., Bozeman). Int. J. Theor. Phys.; 3: No. 2, 133-9(Apr 1970).

Starting from the equations of motion of particles interacting with both electromagnetic and gravitational fields, the (passive) gravitational mass (M_g) and the inertial mass (M_i) of the total system of interacting charges is calculated. It is found that in both Einstein's general relativity and the scalar-tensor gravitational theory of Brans and Dicke, M_g and M_i are both equal to the special relativistic energy of the system of interacting charged particles. Therefore, both theories are compatible with the high accuracy measurements of the M_g/M_i ratio of laboratory objects. (auth)

10604 SPHERICALLY-SYMMETRIC STATIC SOLUTION TO A NEW SCALAR–TENSOR GRAVITATIONAL THEORY. Aragone, C. (International Centre for Theoretical Physics, Trieste, Italy); Restuccia, A. Lett. Nuovo Cim.; 2: No. 23, 1190-2(4 Dec 1971).

A spherically-symmetric static solution to the new scalar-tensor theory recently proposed by Deser (Ann. of Phys., 59: 248(1970)) is shown for the case of the dust cloud. (L.B.S.)

10605 NEWTONIAN GRAVITATIONAL FIELD THEORY. Schwebel, Solomon L. (Boston Coll., Chestnut Hill, Mass.). Int. J. Theor. Phys.; 3: No. 4, 315-30(Aug 1970).

A field theory for gravitation is developed within the framework of the special theory of relativity. This is achieved by exploiting the similarity in mathematical structure of two relations which are found in both Newton's gravitational theory and Maxwell's electromagnetic theory. These relations are: the law of force between the relevant physical entities (mass and electric charge), and the equation of continuity (conservation of charge). The field equations describe the propagation of gravitational waves with the velocity of light in much the same way that Maxwell's field equations describe electromagnetic waves. Both fields have such similar mathematical structures that they are developed in parallel up to the point where their inherently different physical content cause their paths of evolution to diverge. At this stage, the field equations for both theories are determined. The physical significance of the field variables of both theories imposes a mathematical formalism which does not give rise to self-interactions. A calculation for the energy in the field of two particles representative of either the electromagnetic or gravitational field is shown to give the correct finite value. The reason that conventional calculations yield an infinite energy is readily seen to lie in the calculation of a physically meaningless quantity. The mathematical formalism required by the field theories is used to develop generalizations of the usual conservation laws. Two conservation laws are derived which are consequences of the consistent physical interpretation of the field variables. These laws do not appear in conventional theory. The approach followed in developing the field theories leads to the appearance of forces dual to the well-known forces. Thus, for the electromagnetic field, a dual to the Lorentz force is found and, in the gravitational field, a dual is found to Newton's law of gravitation. These results are not due to the introduction of the fields, for they can be expressed in terms of the particle variables. They emerge from the consistent application of the physical interpretation of the particle and field variables. A basic physical principle, which underlies both theories, is best expressed by the statement: It is the interactions between the elements of a physical event and not the elements themselves which are the physical observables. (auth)

10606 POLARIZATION EFFECTS OF ELECTRON SCATTERING IN THE GRAVITATIONAL FIELD OF A ROTATING BODY. Iskhakov, I. F. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 38-42(1971). (In Russian).

The interaction of a quantum spin field with a classical Einstein (or Lenz-Thirring) gravitational field is examined. An attempt is made to evaluate a source with geometrical dimensions considerably greater than the gravitational radius of the source ($R \gg 2\gamma m/c^2$). Polarization effects are considered which did not take place earlier, since they are due to a contribution in the matrix element, arising from the contribution of off-diagonal elements of the matrix tensor. (K.S.W.)

10607 KINETIC APPROACH TO MANY-BODY PROBLEMS IN GENERAL RELATIVITY. Yodzis, P. (New Mexico State Univ., Las Cruces). Int. J. Theor. Phys.; 3: No. 4, 331-6 (Aug 1970).

A new formulation of general relativistic kinetic theory, which includes the effects of "collisions" in a self-consistent way, is given. It is found that if collision terms are necessary in the kinetic equation, then Einstein's field equations must be modified as well. (auth)

10608 SPINNING NULL FLUID IN GENERAL RELATIVITY. Bonnor, W. B. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 3: No. 4, 257-66(Aug 1970).

Exterior and interior solutions of Einstein's equations are given for fluid moving with the speed of light and having a superposed spin. The spin is microscopic and does not refer to the rotation of world lines, which are straight. A strange feature is that the exterior solution is in every case locally isometric to an exterior solution for a nonspinning null fluid. (auth)

10609 GRAVITATIONAL FIELD OF A TACHYON. Vaidya, P. C. (Gujarat Univ., Ahmedabad, India). Curr. Sci. (India); 40: No. 24, 651-4(20 Dec 1971).

A static axially symmetric exact solution of Einstein's equation $R_{ik} = 0$ is interpreted as describing the gravitational field of a tachyon. It is found that under gravitation a tachyon will repel a material particle. (auth)

10610 GENERAL RELATIVITY AND GENERAL LORENTZ COVARIANCE. Treder, Hans-Juergen (Deutsche Akademie der Wissenschaften, Berlin). Int. J. Theor. Phys.; 3: No. 1, 23-31(Feb 1970).

The principle of general relativity means the principle of general Lorentz-covariance of the physical equations in the language of tetrads and metrical spinors. A general Lorentz-covariant calculus and the general Lorentz-covariant generalizations of the Ricci calculus and of the spinor calculus are given. The general Lorentz-covariant representation implies the Einstein principle of space-time covariance and allows the geometrization of gravitational fields according to Einstein's principle of equivalence. (auth)

10611 GENERALIZED VAIDYA METRICS. Hughston, Lane P. (Univ. of Texas, Austin. Massachusetts Inst. of Tech., Cambridge). Int. J. Theor. Phys.; 4: No. 4, 267-71(Aug 1971).

Criteria under which one may construct the energy tensor of a null radiation field from an algebraically special vacuum metric are investigated. The field bears the same relation to the original metric as does Vaidya's to Schwarzschild's. As an example a class of null radiation fields is generated from a class of vacuum metrics without symmetry discovered by Robinson and Robinson. (auth)

10612 TETRADS, ANHOLONOMIC COORDINATES, AND SPACE–TIME GEOMETRY. Gatha, K. M. (Univ. of Singapore); Dutt, R. C. Aust. J. Phys.; 24: No. 5, 631-52(Oct 1971).

Taking the tetrad vectors ${}^a h_\mu$ as the fundamental gravitational variables in Riemannian space–time and using anholonomie Minkowskian coordinates, a more fundamental tetrad-dependent tensor $A_{(\mu\nu)\omega}$ of gravitation is obtained instead of the metric-dependent curvature tensor $R^\mu_{\nu\omega\sigma}$ of general relativity. Invariance under a subgroup of $L^a_b(x)$ transformations of the anholonomic coordinates enables a gravitational Lagrangian to be constructed from $A_{(\mu\nu)\omega}$ which not only predicts the standard results of general

relativity but also provides a unique energy–momentum complex. $A_{\mu\nu\lambda\kappa}$ gives a local dynamical structure to gravitation and plays an important part in cosmology. (auth)

10613 ROBINSON–TRAUTMAN SOLUTION OF EINSTEIN'S EQUATIONS. Foster, J. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 37A: No. 4, 313-14(6 Dec 1971).

Bonnor's argument that the nullicle solution of Robinson and Trautman cannot represent a null particle is further supported by constructing its flat-space electromagnetic analog. (auth)

10614 PROPERTIES OF THE MASS TENSOR. Fikhtengoltz, I. G. (Leningrad Inst. of Precision Mechanics and Optics). Zh. Eksp. Teor. Fiz.; 61: No. 2, 454-6(Aug 1971). (In Russian).

Integral relations for the mass tensor are derived which are applicable to the motion of a small lumped mass. A Lagrangian function yielding correct expressions for the momentum of a given mass and for the force acting on the mass is derived in integral form. (auth)

10615 BEAM INSTABILITY IN GRAVITATING MEDIA. Mikhailovskii, A. B.; Fridman, A. M. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz.; 61: No. 2, 457-68(Aug 1971). (In Russian).

It is shown that in gravitating systems, besides Jeans instability, beam instability may also arise. (auth)

10616 DISPERSION OF GRAVITATIONAL RADIATION. Chesters, Dennis. College Park, Md.; Univ. of Maryland (1971). 123p. University Microfilms Order No. 72-1683.

Thesis.

Weber's recent observations of gravitational waves opens the study of gravitational astronomy. Now, any astronomical observation must be explained not only in terms of emission mechanisms at the source, but also in terms of propagation characteristics along the line of sight. By making calculations analogous to those for the dispersion of radio waves in a collisionless plasma, it is found that short gravitational waves are only slightly dispersed by their interaction with the interstellar medium. (Diss. Abstr. Int., B)

10617 PROPER VIBRATION OF SPACE. II. Kulhanek, J. (Electro Technical Faculty, Podebrady, Czech.). Int. J. Theor. Phys.; 4: No. 3, 217-21(May 1971).

The proper vibrations of homogeneous and isotropic space are characterized by the autonomous conservative oscillation of spatial volume element. The conserved energy of oscillation is different from zero only when the space has positive curvature, and hence, it is closed. However, the oscillations of volume element of closed space imply the change in the signature of first metric form of space–time. This means that the metric actually has singular points. (auth)

Scattering Theory

Refer also to abstracts 10494, 10593, 11003, and 11012.

10618 PROPERTIES OF AMPLITUDES THAT SATURATE THE FROISSART BOUND. Mickens, R. E. (Stanford Univ., Calif.). Lett. Nuovo Cim.; 2: No. 22, 1157-9(27 Nov 1971).

Techniques used to obtain bounds on near-forward scattering amplitudes that violate the Pomeranchuk theorem are applied to the class of amplitudes that satisfy the Froissart bound. Bounds on the elastic cross section, on the zeros, and on the width of the forward peak are obtained. (L.B.S.)

10619 N/D METHOD OFF THE MASS SHELL FOR THE KLEIN-GORDON EQUATION AND THE INVERSION PROBLEM. Weiss, J. (Slovak Technical Univ., Bratislava). Czech. J. Phys.; 21: No. 10, 1032-45(1971).

The relativistic analogon of a procedure demonstrating the link between the S-wave off-the-mass-shell N/D equations (variables: the momentum, energy and radial coordinate of a scattered particle) and the Marchenko equations of the inversion problem is presented in the static scattering. For the Klein–Gordon formalism the transition from the former type of the equations scattering. For the Klein–Gordon formalism the transition from the former type of the equations to the latter requires: a decomposition of the N/D equation quantities into the components without the E-branch points, a suitable deformation of the integration path in the N/D equations and an assumption on the regular behavior of the off-the-mass-shell N function discontinuities. (auth)

10620 RELATIVISTIC JOST FUNCTIONS AND POTENTIALS. Weiss, J. (Slovak Technical Univ., Bratislava). Czech. J. Phys.; 21: No. 10, 1019-31(1971).

An extension of the solution of the inversion problem reproducing the potentials and wave functions from the given singularities of the Jost functions on a static limit relativistic case of the S-wave Klein–Gordon equation is investigated by way of the method elaborated by Petráš in Czech. J. Phys. B12 (1962), 67. It is shown that similarly as in the non-relativistic case, a transparent representation of the relativistic Jost solution permits to determine uniquely the potentials decreasing exponentially at large distances and leads to the dispersive Fredholm integral equations for the Jost solution components. The proposed method might be considered as an alternative to that used by Cornille in J. Math. Phys. 11 (1970), 79. (auth)

10621 GENERALIZATION OF THE NEVEU–SCHWARZ MODEL TO ARBITRARY INTERCEPT. Clavelli, L. J. (Rutgers–The State Univ., New Brunswick, N. J.). Lett. Nuovo Cim.; 2: No. 22, 1160-4(27 Nov 1971).

A simple modification of the Neveu–Schwarz vertex is presented which leads to a factorizable dual model whose four-point function is the Lovelace–Shapiro amplitude irrespective of the pion mass. The generators of the Virasoro algebra are constructed. (auth)

10622 ELASTIC PARTIAL-WAVE AMPLITUDE AND POLES OF HIGHER ORDER. Lokajicek, M. V. (Inst. of Physics, Prague). Czech. J. Phys.; 21: No. 8, 823-7(1971).

Starting from the usual formula for the elastic partial-wave scattering amplitude a new formal decomposition of the phase shift is given which leads to a new more general expression for energy-dependence exhibiting poles of higher order. This decomposition is in agreement with a multichannel decay model of unstable particles, which stands behind this approach. (auth)

10623 SINGULAR POTENTIALS, INDEFINITELY HIGH SPIN, AND MATHEMATICAL DUALITY. Misra, R. C.; Ross, W. R. (Univ. of New Brunswick, Fredericton). Lett. Nuovo Cim.; 2: No. 23, 1214-16(4 Dec 1971).

A crossing-symmetric model is proposed to show that singular potentials of the form γ^{-n}, $n > 3$, exhibit mathematical duality. (L.B.S.)

10624 MULTIPARTICLE PARTIAL-WAVE AMPLITUDES AND INELASTIC UNITARITY. I. GENERAL FORMALISM; RACAH COEFFICIENTS FOR THE POINCARE GROUP. Klink, William H. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 4: No. 8, 2260-80(15 Oct 1971).

Multiparticle partial-wave amplitudes are defined for arbitrary scattering processes. Unitarity conditions are then imposed at arbitrary energies, resulting in nonlinear relations between the multiparticle partial-wave amplitudes. It is pointed out that the derivation of such unitarity relations is equivalent to finding the Racah coefficients for the Poincaré group. These coefficients, as with other quantities, are derived for particles with arbitrary spins, masses, and boosting operations. Complications due to identical particles are also discussed. (auth)

10625 FUNCTIONAL-INTEGRAL APPROACH TO DUAL-RESONANCE THEORY. Gervais, J.-L. (Univ., Paris); Sakita, B. Phys. Rev., D; 4: No. 8, 2291-2308(15 Oct 1971).

It is shown that dual-resonance amplitudes can be expressed in terms of rudimental amplitudes defined by functional integrals which correspond to transition amplitudes of quantum-mechanical systems of strings with imaginary time. The equivalence between the path-integral and operator formulation of quantum mechanics is used to establish the connection between this approach and the usual operator approach. The factorization of rudimental amplitudes is studied to obtain the Feynman-like rules for dual-resonance amplitudes. N-Reggeon vertices are expressed in terms of rudimental amplitudes, and the propagator, which is shown to be the usual spurious-free twisted propagator is determined. N-loop orientable diagrams are calculated. In general, the functional integrals considered can be calculated by solving appropriate Neumann's boundary-value problems of corresponding bounded Riemann surfaces. This provides a generalization of the analog model to the case of external Reggeons which are described by extended momentum distributions on the boundaries. (auth)

10626 ANALYTIC CONTINUATION IN HELICITY AND O(2,1) EXPANSIONS. Jones, C. E.; Low, F. E.; Young, J. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 8, 2358-63(15 Oct 1971).

The analytic continuation of an azimuthal angular variable in a scattering process to a channel where it may take on large imaginary values is discussed. The asymptotic behavior of the many-particle amplitude for large values of that variable is shown to be governed by singularities in an analytically continued helicity amplitude. The procedure is analogous to the usual Regge-Sommerfeld-Watson transformation relating large-$\cos\theta$ behavior

to singularities in analytically continued angular momentum amplitudes. (auth)

10627 ELEMENTARY DISCONTINUITY FORMULAS AND MUELLER'S REGGE HYPOTHESIS. Tan, Ching-i (Brown Univ., Providence). Phys. Rev., D; 4: No. 8, 2412-19(15 Oct 1971).

Mueller's recent work on inclusive cross sections is interpreted in terms of the elementary discontinuity equations for multiparticle scattering amplitudes. The paths of continuation for obtaining these discontinuities are given. It is found that, in order to make the identification meaningful, the emergence of anomalous thresholds is necessary to "shield" the effects of box-diagram Landau singularities. It is also discussed how Mueller's Regge hypothesis can be derived from the multi-Regge model, provided singularities other than normal thresholds are absent in the asymptotic expansion. (auth)

10628 HIGH-ENERGY PRODUCTION PROCESSES IN THE EIKONAL APPROXIMATION. Tanaka, Syu (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 4: No. 8, 2419-31(15 Oct 1971).

For high-energy production processes, the factorization properties of inelastic effects on the elastic amplitude are studied, first by the eikonal approximation method in a perturbative approach (without assuming the momentum of a produced particle is small), and second by functional methods for many- but soft-particle production. The latter corresponds to the situation in the Bloch-Nordsieck model. (auth)

10629 AMPLITUDES WITH SCHWARZ-TYPE REGGE TRAJECTORIES. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 8, 2569-71(15 Oct 1971).

Amplitudes containing Schwarz-type Regge trajectories must satisfy certain constraints. Some recent examples in the literature do not do so. (auth)

10630 INTEGRAL REPRESENTATION FOR THE FORWARD SCATTERING AMPLITUDE. Nakanishi, Noboru (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 4: No. 8, 2571-3 (15 Oct 1971).

The two-variable perturbation-theoretical integral representation (the Deser-Gilbert-Sudarshan representation) for the off-the-mass-shell forward scattering amplitude is explicitly proved to all orders in perturbation theory under certain natural spectral conditions. (auth)

10631 VALIDITY OF EIKONAL-TYPE APPROXIMATIONS FOR POTENTIAL SCATTERING. Kujawski, E. (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 8, 2573-7(15 Oct 1971).

It is shown that for a wide class of potentials the slightly modified form of the Glauber eikonal approximation, recently proposed by Abarbanel and Itzykson, is essentially equivalent to the simplified form of the Saxon-Schiff formula obtained by Sugar and Blankenbecler. Insight into the relationship among several high-energy approximations is thereby gained. It is then suggested that the above modified Glauber approximation may possess a rather large angular range of validity and may be as reliable as several of the recently proposed "improved" high-energy approximations. This is also numerically illustrated. (auth)

10632 GENERAL DUAL OPERATORIAL VERTICES. Corrigan, E.; Montonen, C. (Cambridge Univ., Eng.). Nucl. Phys.; B36: No. 1, 58-72(1972).

The N-reggeon vertex is constructed for a large class of factorizable dual resonance models by representing the constituent Möbius transformations in different unitary irreducible representations of SU(1,1). The conventional model and the model of Neveu and Schwarz emerge as special cases. The requirement of the existence of an infinite set of gauge operators restricts the number of representations that can be used. (auth)

10633 APPLICABILITY OF THE NEWTON–KANTOROVICH METHOD AND OPTIMIZATION THEORY TO DISPERSION RELATIONS OF THE CHEW–MANDELSTAM TYPE. Chung, K. P. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Nucl. Phys.; B36: No. 1, 253-77(1972).

The mathematical structure of the Chew–Mandelstam type dispersion relations is examined to determine if the Newton–Kantorovich method of solution can be applied. Constructive methods for finding the solutions without the N/D factorization are worked out. The numerical techniques for solving nonlinear integral equations with Cauchy kernels on the basis of the Newton–Kantorovich method and the optimization procedure are applicable to a wide variety of problems in the S-matrix theory. (auth)

10634 SCATTERING OF PARTICLES BY LONG-RANGE POTENTIALS. Baryshevskii, V. G.; Korennaya, L. N.; Feranchuk, I. D. (Belorussian State Univ., Minsk). Zh. Eksp. Teor. Fiz.; 61: No. 2, 469-75(Aug 1971). (In Russian).

Scattering of particles by long-range potentials is investigated. It is shown that a consistent analysis of development of the collision process leads to results which significantly differ from those of stationary scattering theory. It is found that for long-range potentials the quantity playing the role of a scattering cross section depends on the coordinate of the source and detector. These anomalies are manifest in depolarization processes of the colliding particles beams and also in inelastic scattering processes. (auth)

10635 ACCOUNT OF EXCHANGE INTERACTION IN SCATTERING ON SMOOTH QUASIPOTENTIAL. Arkhipov, A. A.; Savrin, V. I.; Tyurin, N. E. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 14: No. 5, 1066-70(Nov 1971). (In Russian).

Exchange forces are accounted in the case when the interaction between particles is described by the smooth complex quasipotential. (auth)

10636 THREE-DIMENSIONAL RELATIVISTIC EQUATIONS APPLIED TO SOME PROBLEMS OF THREE BODY THEORY. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 5, 1091-1100(Nov 1971). (In Russian).

Based on the Faddeev relativistic equations obtained in the framework of a three-dimensional formulation of the quantum field theory, the following problems of the relativistic theory: (a) separable approximation in the two- and three-body problem, (b) partial wave analysis of the three-particle equations, (c) high-energy scattering on a compound weakly-bound system are considered. The arguments are given in favor of the transition from nonrelativistic equations to relativistic ones results in an increase of the bound-state energy. It is shown that the well known Glauber formula for the problem (c) may be obtained only with a stronger assumption on the two-particle amplitude behavior. (auth)

Particle Accelerators

Refer also to abstracts 10020, 10382, and 10433.

10637 (AECD/EP–22) SIMPLE SCATTERING CHAMBER. Ahmed, Motaheruddin (Atomic Energy Centre, Dacca (Pakistan)). Jun 1971. 5p. Dep. NTIS (U. S. Sales Only).

A scattering chamber for studying charged particle induced reactions has been designed and fabricated. The special feature of this chamber lies in its simplicity of construction as well as operation. Yet it fulfills the basic requirements of charged particle scattering experiments, i.e., rotations of the particle detector and the target around the axis of the chamber without disturbing the vacuum inside and a proper monitoring of the incident beam. (auth)

10638 (BNL–16131) LONG DUTY CYCLE BEAM SEPARATION DEVELOPMENTS. Brown, H. N.; Foelsche, H. W.; Halama, H. J.; Lazarus, D. M. (Brookhaven National Lab., Upton, N. Y.). [1971]. 10p. (CONF-710908–5). Dep. NTIS.

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The subject of beam separators with long duty cycle for electronic experiments is reviewed. Room-temperature long-pulse RF beam separators and superconducting RF separators are discussed with emphasis on recent beam design studies at Brookhaven. For room-temperature devices the high power requirements mandate a choice of very long traveling wave structures embedded in an optical focusing channel. Specific beam designs for intermediate and high energy regions have been studied and a new marching system for high solid angle has been designed. Expected-particle yields for various separation techniques are compared. Maximum yields of the order of 10^8 K^+-mesons per 10^{12} interacting protons seem achievable at the AGS. (auth)

10639 (BNL–50310) PROCEEDINGS OF THE SYMPOSIUM ON ION SOURCES AND FORMATION OF ION BEAMS, OCTOBER 19–21, 1971, UPTON, NEW YORK. Sluyters, Th. J. M. (ed.) (Brookhaven National Lab., Upton, N. Y.). Oct 1971. 299p. (CONF-711012). Dep. NTIS.

Separate abstracts were prepared for 25 of the 44 papers presented. Seven of the papers were out of scope and 12 of the papers were previously included in NSA. For abstracts of these 12 papers see CONF-711012 in a cumulative report number index. (W.H.K.)

For abstracts of individual papers see: 10019, 10259, 10260, and 10640–10661.

10640 (BNL–50310, pp 1-7) DIVERSITY AND UNITY IN SOURCES AND BEAMS. Lawson, J. D. (Rutherford High Energy Lab., Chilton (England)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

After a discussion of the apparent diversity of the requirements for ion sources, and the factors which appear to limit their performance in different situations, it is suggested that nevertheless some underlying unity can be found, but that this is sometimes obscured by different viewpoints and terminology. An example of this unity is provided by the paraxial beam envelope equation for beams with finite emittance and a "normal" phase space distribution. The equation is written down in general form, using simple but fully relativistic notation. Various physical situations, usually treated separately, are illustrated by taking different selections from the seven terms. This is followed by a brief discussion of recent work on more realistic phase space distributions. Finally, some brief remarks are made about the complicated behavior of the actual source plasma and its boundary, and a comment on the future outlook is made. (auth)

10641 (BNL–50310, pp 9-16) EXTRACTION OF IONS FROM GAS DISCHARGE SOURCES. Septier, Albert (Paris Univ., Orsay (France). Institut d'Electronique Fondamentale). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

After a brief account of the ideas of emittance and brightness of a source, a thorough examination of the properties of the emissive surface of a plasma provides an explanation of the basic differences between electron guns and intense ion sources and of the superiority of sources that emit ions with high directed velocities. The various extraction techniques used in the main types of sources are described. The difficulties encountered in writing general computer programs for designing high quality optical systems as extractors are summarized. (auth)

10642 (BNL–50310, pp 17-19) USE OF A SPIKE CATHODE WITH A DUOPLASMATRON ION SOURCE. Chapman, K. R.; Rowton, L.; Trimble, S. (Florida State Univ., Tallahassee). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

With the use of a plasma-expansion cone to obtain increased output, higher arc currents were necessary to obtain the full advantage of the expansion cone. These increased currents reduce filament life considerably and would require a heavier gage filament wire, with higher heat dissipation in the source head, to give an acceptable life. An alternative cathode consisting of a tungsten spike was constructed and has proved very satisfactory. (auth)

10643 (BNL–50310, pp 21-5) ANALYTICAL APPROACH TO THE DESIGN OF A PLASMA EXPANSION CUP. Kovarik, V.; Sluyters, Th. (Brookhaven National Lab., Upton, N. Y.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Proper matching and transport of the extracted ion beam from the plasma surface has been accomplished by the adaption of the Pierce geometry. The region between formation of the plasma in the discharge and the plasma boundary is considered. Proper transport of the primary plasma that is produced in the source and the secondary plasma that is produced in the cup may improve the emittance. It is shown that a significant part of the ions is due to ionization in the cup. These ions will have a directed velocity mainly determined by the physical shape of the expansion chamber in the absence of a magnetic field. (auth)

10644 (BNL–50310, pp 27-34) THEORETICAL AND EXPERIMENTAL STUDY OF THE GAS EFFICIENCY IN A DUOPLASMATRON ION SOURCE. Lejeune, Claude (Paris Univ., Orsay (France). Institut d'Electronique Fondamentale). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The duoplasmatron discharge has two distinct regimes showing themselves by a break in the curves giving variations of arc potential and of extracted ion current as functions of the arc discharge current or gas pressure. All the emissive properties of the ion source present interesting peculiarities when the arc is working near the regime change over point, for instance the extracted ion current and the ionization efficiency are maximum. Experimental study of the ionized gas allows to describe the different plasmas of the discharge and to specify the physical processes governing their behavior in the two modes of the arc. The basis of the quantitative model of the arc is presented. Its main provisions are in good agreement with experimental data for the discharge properties as well as for the source qualities. Similarity rules of the duoplasmatron type ion source are deduced. They allow the determination of the optimum parameters—for construction and operation of the source—adapted to any specific problem. (auth)

10645 (BNL–50310, pp 107-12) DENSITY DISTRIBUTION MEASUREMENTS ON THE SATURNE 750 keV PREINJECTOR BEAM. Chamouard, P. A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Experiments with the 750-keV preinjector at Saturne to improve beam brightness are described. The setup to measure beam emittance is briefly described, and the modified plasma expansion cup is discussed. (W.H.K.)

10646 (BNL–50310, pp 121-8) PRELIMINARY STUDY OF ION SOURCE AND HIGH GRADIENT COLUMN. Fukumoto, S.; Inagaki, S.; Kobayashi, M.; Nishikawa, T.; Takami, S. (National Lab. for High Energy Physics, Tsukuba (Japan)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A duoplasmatron is tested for the ion source of the Japanese proton synchrotron project. To extract high current ion beams, a large plasma expansion cup is examined, the inside diameter of which is 2.5 cm, and 200 mA beam is obtained, however, the emittance of the beam is large. It is measured by slits and an aluminized quartz plate, the images of the slits are photographed from outside of the vacuum vessel through a glass window. The normalized emittance thus obtained is $\epsilon = 0.5$ cm-mrad for 100 mA beam. The proton percentage is about 75%. To improve the beam quality, a plasma cup with a multi-stage expander is tested and the emittance of 0.14 cm-mrad is obtained for 70 mA beam. The maximum current is 400 mA. A vertical model of the open type high gradient accelerating column is designed and constructed. Ions are to be accelerated to 750 keV in an 18 cm accelerating gap which consists of 5 gaps of Pierce type electrodes. They are made of pure Ti plates and are mounted on stainless steel supports. The accelerating tube consists of 9 units, a unit is made of 2 porcelain rings and 3 voltage dividing electrodes. The inner diameter and height of the ring are 56.5 cm and 5.5 cm respectively. The voltage dividing electrodes are made of 13-Cr stainless steel plates for their moderate thermal expansion coefficient. Araldite AW 106 is used for adhesion of the rings and the electrodes. Viton "O" rings seal the units. The column is now being tested without ion beams. (auth)

10647 (BNL–50310, pp 129-35) INTENSE ION AND NEUTRAL BEAMS WITH EXTRACTION ENERGIES ABOVE 10 keV. Morgan, O. B. Jr. (Oak Ridge National Lab., Tenn.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

There are several ion sources now existing that can be used to produce ampere ion beams. The most versatile, simple, compact and efficient of these are modifications of the duoplasmatron. Producing bright ≈0.5 A ion and neutral particle equivalent beams from these sources at energies above ≈100 keV is possible with single aperture axisymmetric extraction systems. Multi-aperture extraction systems make it possible to extract multi-ampere bright ion beams at energies of tens of keV. These multi-ampere systems require large plasma surfaces with a uniform density. The duoPIGatron is an example of an efficient plasma source that has been developed for these multi-aperture systems. Converting these ion beams to multi-ampere equivalent neutral particle beams becomes very difficult for energies above tens of keV. Future needs of fusion research will require more research on ion sources and accelerators to produce the multi-ampere equivalent, MW, steady state injector systems that will probably be needed. (35 references.) (auth)

10648 (BNL–50310, pp 151-5) SOME FACTORS AFFECTING THE EMITTANCE OF A 100 mA dc DUOPLASMATRON. Ormrod, John H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A 100 mA dc duoplasmatron ion source is described. The emittance of the source is dominated by the shape of the plasma-beam boundary which gives a triple peaked emittance pattern. The width of these individual peaks is a measure of the inherent transverse momentum distribution of the ions in the expansion cup. This distribution is affected by the electric and magnetic fields in the source, and some factors that reduce the momentum spread are discussed. (auth)

10649 (BNL–50310, pp 207-22) SURVEY OF GROUND STATE ATOMIC BEAM SOURCES. Glavish, H. F. (Stanford Univ., Calif.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Present ground state atomic beam polarized ion sources are reviewed. The principle of this type of source is discussed briefly, including an account of the main sources of depolarization. Specific developments are considered which have occurred in the last five years. These concern ionization, production of polarized negative ions by charge exchange in sodium vapor, polarization control, and injection into cyclotrons and tandem Van de Graaff accelerators. A section is devoted to future developments which may lead to a higher intensity. (81 references.) (auth)

10650 (BNL–50310, pp 223-30) REVIEW OF LAMB-SHIFT POLARIZED ION SOURCES. Clegg, Thomas B. (North Carolina Univ., Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The recent developments in the field of Lambshift polarized ion sources are reviewed with an emphasis on the experimental techniques used on the sources now operating and being built. (52 references.) (auth)

10651 (BNL–50310, pp 231-6) STATUS REPORT ON THE ZERO GRADIENT SYNCHROTRON (ZGS) H^- ION SOURCE PROGRAM. Fasolo, J. A.; Marmer, G. J.; Moenich, J. S. (Argonne National Lab., Ill.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

During April, the H^- ion source was installed in the 750-kV terminal of the high gradient column of the ZGS and used for tests of H^- injection into the booster (the former Cornell synchrotron). A negative ion beam of 7 mA was accelerated to 750 keV; 6 mA of this was transported to the linac and ~3 mA was injected into the linac. With the buncher removal for modification, one-fourth of the injected beam (~0.75 mA) was accepted and accelerated to 50 MeV. One-third of the 50-MeV beam was transported to the booster, where it gave a circulating proton current of 30 mA. The H^- run was terminated on April 22 to permit reconversion to proton operation and resumption of ZGS operation following completion of repairs to the octant 3 magnet coil. During construction of a new ion source test facility, nearing completion, a number of source design modifications have been made in an effort to correct shortcomings discovered during the H^- injection tests. The most important of these modifications are concerned with reduction of heavy ion contamination. (Emittance studies at 750 keV revealed that ~60% of the negative ion beam consisted of ions in the mass range from 16 to 18 amu.) (auth)

10652 (BNL–50310, pp 237-44) NEGATIVELY CHARGED ATOMIC AND MOLECULAR IONS. Kaiser, H. J.; Heinicke, E.; Baumann, H.; Bethge, K. (Heidelberg Univ. (West Germany). Physikalisches Institut (II)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The production of positive and negative ions of all elements of the sub-groups A and some of the sub-groups B has been investigated as an extension of previous work on Penning sources. Molecular ions of the type $X_n^{\pm}$, n > 1 and ions of the hydride molecules $X_nH_m^{\pm}$, n, m > 1 have been found. The maximum number m_{max} of the H atoms bound in the cluster is determined by the position of the element in the periodic system. During these investigations some peaks appeared in the mass spectra which correspond to masses half of that of the negative ion X^-. The electric and magnetic deflection of these ion beams has shown that these beams are particularly composed of doubly charged negative ions. Beam intensities of O^{2-}, Te^{2-}, Bi^{2-}, F^{2-}, Cl^{2-}, Br^{2-} and I^{2-} were measured on the order of 0.2 to 2 nA. (auth)

10653 (BNL–50310, pp 245-8) RUTGERS UNIVERSITY GROUND STATE ATOMIC BEAM POLARIZED ION SOURCE. MacKinnon, B. A.; Ruffell, J. P.; Walker, I. J. (Auckland Nuclear Accessory Co. (New Zealand)); Robbins, A. B.; Boyd, R. N. (Rutgers–The State Univ., New Brunswick, N. J.); Glavish, H. F. (Stanford Univ., Calif.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A polarized proton and deuteron source, based on magnetic separation of a ground state atomic beam, has been built for the Rutgers University FN Tandem Van de Graaff by Auckland Nuclear Accessory Company (ANAC), under a contract between Rutgers University and ORTEC Incorporated. Negative ions are formed by charge exchange in sodium vapor. Any direction is possible for the spin axis by using two 90° electrostatic deflections and two spin precession solenoids. In factory tests at ANAC, H^- and D^- currents in excess of 200 nA were achieved with a high ion optic beam quality. Using the $^3H(d,n)^4He$ reaction, polarizations of $P_{zz} = \pm 0.84$ were measured. (auth)

10654 (BNL–50310, pp 249-56) PARAMETRIC STUDY OF A NEGATIVE ION DUOPLASMATRON. Wells, Nikita; Hanley, Peter R. (Radiation Dynamics, Inc., Westbury, N. Y.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A parametric study of the operation of a direct-extraction negative-ion duoplasmatron has been undertaken to optimize the parameters of the source. In a conventional geometry, 230 μA of H^- beam was obtained from a 1.3 mm diameter anode aperture, offset 1.0 mm from the discharge axis. Attempts to extract high currents from a concentric annular ring of anode apertures resulted in significantly lower specific yields: i.e., lower current per unit aperture area. Experiments with an anode aperture drilled off-center from the discharge axis show that the distortion of the source magnetic field that results from offsetting the intermediate electrode has a strong effect on the intensity of the extracted beam. (auth)

10655 (BNL–50310, pp 261-2) UNIVERSITY OF WASHINGTON LAMB SHIFT POLARIZED ION SOURCE. Preikschat, E.; Roth, G. W.; Cramer, J. G.; Weitkamp, W. G. (Washington Univ., Seattle). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A polarized negative ion source has been constructed and installed on the University of Washington Tandem Van de Graaff accelerator. The Lamb shift source uses a Sona field reversal scheme to increase the polarization. Proton beams of 50 nA with 83% polarization and tensor polarized deuteron beams of 60 nA have been observed on target. (auth)

10656 (BNL–50310, pp 263-7) COMPACT POLARIZED ION SOURCE FOR THE HIGH VOLTAGE TERMINAL OF THE OHIO STATE UNIVERSITY 6-MeV VAN DE GRAAFF ACCELERATOR. Paetz gen. Schieck, H.; Busch, C. E.; Keane, J. A.; Donoghue, T. R. (Ohio State Univ., Columbus. Dept. of Physics). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A compact ion source of polarized protons and deuterons has been constructed for the high voltage terminal of a pressurized 6-MeV Van de Graaff accelerator. The source is of the atomic beam type. The major difficulty of pumping the source adequately was overcome by using three modified wire-fed titanium sublimation pumps. To conserve power, permanent magnets are used whenever possible, such as in the sextupole separation magnet and in the rf transition magnets. A rotatable Wein filter is also included to permit complete versatility in precessing the spin quantization axis to any orientation at any one of the beam line assemblies. During the recent installation of the source in the high voltage terminal, the vector and tensor polarization of the extracted deuteron beam was measured. (auth)

10657 (BNL–50310, pp 269-72) LAMB-SHIFT POLARIZED ION SOURCE WITH SPIN FILTER. Sanada, J.; Mikumo, T.; Katori, K.; Seki, S.; Tagishi, Y.; Nojiri, Y. (Tokyo Univ. of Education (Japan). Dept. of Physics); Kobayashi, S.; Sakaguchi, H. (Kyoto Univ. (Japan)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The present status of the Lamb-shift polarized ion source with spin filter is described. Some improvements on the parts of the apparatus have been made. Typical beam characteristics are the following: the beam intensity is around 100 nA and the highest polarization obtained is 50%. (auth)

10658 (BNL–50310, pp 277-84) INFLUENCE OF EXTRACTION GEOMETRY ON A NEGATIVE HELIUM ION SOURCE WITH AN EXPANDED PLASMA. Greenway, T. J. L.; Hyder, H. R. M. (Oxford Univ. (England). Nuclear Physics Lab.). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The intensity and shape of a beam of positive helium ions extracted from a duoplasmatron have been measured as the dimensions of the plasma expansion cup and extraction electrode were varied. The effects of the source operating parameters were also examined and an arrangement was found which yielded an intense positive ion beam with low divergence. This beam was passed through an electron donor canal using lithium vapor and the emittance of the resulting negative ion beam was measured after magnetic analysis. (auth)

10659 (BNL–50310, pp 285-8) OPERATION OF A H.V.E.C. DIODE ION SOURCE FOR THE INJECTION OF NEGATIVE IONS

INTO THE K.S.U. TANDEM VAN DE GRAAFF ACCELERATOR. Hartnell, G. W.; Legg, J. C.; Macdonald, J. R.; Seaman, G. G. (Kansas State Univ., Manhattan). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The successful operation is reported of the H. V. E. C. Diode Ion source as the sole injector of negative heavy ions into the K. S. U. tandem Van de Graaff accelerator. Small but important changes in the construction of the source have been made in order to improve the reliability and stability of operation. Using the diode source for injection of either elemental or radical negative ions, adequate beams have been accelerated of various isotopes of H, C, N, O, F, Si, S, Cl, and Br. Attempts to accelerate Li, B, and P have been unsuccessful using the diode source. (auth)

10660 (BNL-50310, pp , 289-94) DIRECT EXTRACTION NEGATIVE ION SOURCE FOR THE TANDEM ACCELERATOR. Masuda, Seizo (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa Prefecture (Japan)). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The 10 MeV tandem accelerator at the University of Tokyo was installed in 1965 by Tokyo Shibaura Electric Co., Ltd. It went into operation in 1967 and is now used for studies in nuclear structure. Between 1965 and 1969, several minor modifications were made and in early 1970, the old negative ion source was replaced by a new ion source developed by the company. A detailed description of a direct extraction negative ion source for it is given together with a negative ion beam injection system. (auth)

10661 (BNL-50310, pp 295-7) NEGATIVE ION SOURCES FOR THE UNIVERSITY OF WISCONSIN'S TANDEM ACCELERATOR. Richards, H. T. (Wisconsin Univ., Madison). Oct 1971.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Since 1966 a Cs charge exchange source has provided microampere beams of He^- ions. A local version of LASL's direct extraction source has supplied H^-, D^-, C^-, NH_2^-, O^-, F^-, Cl^-, S^- beams for injection into the Wisconsin tandem accelerator. The operating experience with these sources and certain of their special features are reported. Also, development work on the DUODEHCATRON source (which replaces the filament of the direct extraction source with a hollow cathode arc in argon gas) and a Li^- source is reported. (auth)

10662 (CEA-CONF-1879) HIGH INTENSITY E.C.R. STRIPPED ION SOURCE. Bliman, S.; Geller, R.; Hess, W.; Jacquot, B.; Jacquot, C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 11p. (CONF-711021-5). Dep. NTIS (U. S. Sales Only).

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

An ion source based on E.C.R. heating in a magnetic bottle is described. The characteristics of the plasma are: $n \simeq 10^{12}$ cm^{-3} $W^- > 1$ keV $W^+ \sim 10$ eV, $p > 10^{-5}$ torr. The microwave power $P \leq 2$ kW at 10 GHz is coupled to the electrons either by a standing wave or a propagating wave. It is shown that when the extraction electrode is located just beyond the mirror plane of the magnetic bottle, high intensity ion beams are obtained at low voltage extraction V. This result is due to the formation of a sheath between the plasma and the first electrode. In the sheath the ions acquire a preacceleration V_0 and the ion current is limited by $[V_0^{1/2} + V^{1/2}]$ instead of $V^{1/2}$. Such an ion source also produces highly stripped nitrogen ions by single electron impact and preliminary results with a 16 mA beam gave $N^+ = 44\%$; $N^{2+} = 36\%$; $N^{3+} = 14\%$; $N^{4+} = 4\%$; $N^{5+} + N^{6+} + N^{7+} = 2\%$. However due to the presence of H_2^+ the rate of N^{6+} and N^{7+} could not be measured correctly. In order to obtain a correct estimation the ion source is being rebuilt in such a way that the partial hydrogen pressure in the plasma will be below 10^{-10} torr. (auth)

10663 (CONF-711021-3) PERFORMANCE OF A PENNING ION SOURCE IN THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Mallory, M. L.; Hudson, E. D.; Fuchs, G. (Oak Ridge National Lab., Tenn.). [1971]. 7p. Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

One year of operation of a heavy-ion Penning source in the Oak Ridge Isochronous Cyclotron has resulted in the acceleration of a number of isotopes of 17 elements, ranging from boron to tantalum. The method of positive identification of these beams and the operational techniques used to develop certain beams are described. Comparison of the extracted particle current for a given charge state with the calculated ionization potential has resulted in a systematic understanding of particle currents to be expected for undeveloped beams. In particular, shell effects and total ionization potential must both be considered in predicting beam intensities. The particle currents of Ar^{8+}, Ar^{9+} and Ar^{10+} provide a sensitive test for the comparison of multiple and single impact calculations. The data are in agreement with multiple impact calculations. Also, low energy x-rays emitted from the Penning source have been detected and the observed spectra characterize the two modes of source operation. (auth)

10664 (CONF-711021-6) THEORETICAL CALCULATION OF SINGLE AND MULTIPLE IMPACT CHARGE DISTRIBUTION FOR HEAVY ION SOURCES. Fuchs, G. (Oak Ridge National Lab., Tenn.). [1971]. 10p. Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

The optimal design of sources for multiply-charged heavy ions depends upon a better understanding of the physical processes involved. The equations for ionization are developed and discussed. Charge state distributions are calculated for the single impact model (the simultaneous removal of several electrons from an atom) and for the multiple impact (the removal of one electron at a time) model. The calculated ion charge distributions are then compared with experimental data from Penning sources, for which the multiple impact process appears to predominate. (auth)

10665 (IAE-1983) MONTE CARLO CALCULATIONS OF NEUTRON SLOWING DOWN IN TARGETS OF ELECTRON ACCELERATORS. Knizhnikov, Yu. N. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Time-of-flight pictures of decelerated neutrons were statistically calculated from a target installation in a high-powered electron accelerator. The calculations are directed toward design optimization of a water-moderated uranium target for a pulsed neutron source. The numerical results indicate the neutron yield as functions of the thickness of the moderating water layer and of the energy of the respective neutron groups. (K.S.W.)

10666 (INR-P-1287) PULSE RADIOLYSIS INSTRUMENTATION OF THE LAE 13-9 LINEAR ELECTRON ACCELERATOR. Zagorski, Zbigniew P.; Zimek, Zbigniew (Institute of Nuclear Research, Warsaw (Poland)). 1971. 9p. (CONF-710517-5). Dep. NTIS (U. S. Sales Only).

From third symposium on radiation chemistry; Tihany, Hungary (10 May 1971).

Basic features of the electron linear accelerator of LAE 13-9 are described. A pulse radiolysis measuring system has been developed for the study of intermediate kinetics. The system is based on the absorption of external or internal sources of analytical light. The first results of measurements performed were obtained using Cherenkov light as the internal source. (auth)

10667 (ITEF-803) ELECTROSTATIC CONDENSERS IN VACUUM (REVIEW). Ergakov, V. A.; Kryuchkov, I. I.; Trebukhovskii, Yu. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 37p. (In Russian). Dep. NTIS (U. S. Sales Only).

Aspects of choosing the kind and pressure of residual gas and of electric materials to obtain the maximum electric field in the 2 to 20 cm gap of an electrostatic condenser with a pair of parallel plane electrodes in the vacuum are described. Some questions of choosing electrode materials and methods for obtaining the uniform electric field along insulators are discussed. The construction of the bushings (250 kV to 1 mV) is given. (26 references) (auth)

10668 (ITEF-822) INVESTIGATION OF THE ACCELERATION REGIME IN A LINEAR ION ACCELERATOR BY MEANS OF A SPECTROMETER WITH FIXED TUNING. Batalin, V. A.; Kolomiets, A. A.; Kuibida, R. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

A new method for obtaining basic parameters of the longitudinal movement of particles in linacs during a beam pulse is described. The results of measurements for the I-2-ITEP PS linac are given. (auth)

10669 (IYAF-45-70) PHASE STABILITY OF THE MOTION OF MANY BUNCHES IN CHARGED PARTICLE STORAGE DEVICE. Karliner, M. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The conditions for phase stability of motion of many clusters were investigated in storage devices for relativistic particles during electromagnetic interaction of a beam with the outer system. For the most characteristic case of identical clusters, the number of which is equal to the multiplicity of radiofrequencies, the conditions of instability were obtained in the form of a system of in-

equalities, each of which assures stability for the corresponding symmetrical mode of vibration. The special features of the case of many clusters are analyzed and contrasted with a single cluster. A formula is offered for increments of instability of symmetrical modes. (tr-auth)

10670 (IYAF–203) CONCLUSIVE EXPERIMENTS ON THE GENERATION OF LIMITING CURRENT IN THE B-3 BETATRON WITH SPIRAL ACCUMULATION. Boriskin, A. G.; Goryachev, S. B.; Meshkov, I. N. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1968. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

The maximal currents with the injection energy 220 and 400 keV are obtained in the betatron with electron spiral stacking. The corresponding currents are equal to 100 and 300 Amps (or 10^{13} and 3×10^{13} particles for pulse), the final orbit radius was equal to 85 cm, and the energy of the accelerated electrons was equal to 7 MeV. The radial and vertical beam dimensions were equal to ±8 cm and ±4 cm. The obtained currents are maximal ones for the B-3 accelerator and depend on the injection energy and the vacuum chamber dimensions. The discussion of the results shows that the beam current is limited by the parametric resonance of the incoherent betatron oscillations. No instabilities were observed in the intensive electron beam acceleration. (auth)

10671 (JINR–P9-6081) BEAM FOCUSING IN THE ELECTRON CONDUCTOR OF THE COLLECTIVE ACCELERATOR MODEL. Belyaev, A. P.; Ryl'tsev, P. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The focusing system for the electron conductor of the collective accelerator model has been calculated for the transportation of the electron beam with a current of 50 to 150 A, an energy of 1.5 to 2.5 MeV and an emittance of 20 to 100 mrad. cm. Focusing is performed by means of magnetic lenses. The diagrams of the beam envelope functions in the drift intervals are given. The values of the magnetic fields at the axis of the electron conductor and the location of the focusing lenses for various operation regimes of the accelerator are indicated. (auth)

10672 (JINR–P13-6058) PRODUCTION OF THE JET-TARGET FROM CONDENSED HYDROGEN IN VACUUM. Bartenev, V. D.; Valevich, A. I.; Pilipenko, Yu. K.; Smelyanskii, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The development of the technique of jet-target production is discussed. An experimental device is described which produced a jet of hydrogen of diameter 8 to 13 mm and a density of about 10^{-6} g/cm^3. The jet was very well observed visually and recorded by camera. The jet-target was obtained in the Joint Institute for Nuclear Research. (auth)

10673 (JINR–P16-6057) NEUTRON SPECTRA BEHIND THE SHIELD OF THE JINR SYNCHROPHASOTRON. Zaitsev, L. N.; Kimel, L. R.; Rastsvetalov, Ya. N.; Sidorin, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The fast neutron spectra were measured with the help of the nuclear emulsions of the BYa-2 type as well as the spectra of high energy neutrons (E > 20 MeV) measured with the help of the emulsions of the BR-2 type behind shieldings of various thicknesses. The technique of reconstruction of the neutron spectra over the star production in nuclear emulsions is described. The obtained results are compared with the literature data. (auth)

10674 (JINR–P16-6059) FOREMAGNET OF THE SLOW PROTON EXTRACTION SYSTEM AS A SOURCE OF THE SECONDARY RADIATION IN THE JINR SYNCHROPHASOTRON. Zaitsev, L. N.; Kimel, L. R.; Rastsvetalov, Ya. N.; Sidorin, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The experimental data on the angular distribution of the secondary radioactive particles near the septum and data on the space distribution of these particles along the vacuum chamber of the synchrotron are obtained in the regime of dumping of the accelerated proton beam at 10 GeV/c to the septum of the foremagnet. These data can be used by determining the radiation situation and in calculating the local shielding at the JINR synchrotron at decreasing intensity of the accelerated proton beam. (auth)

10675 (KFK–1371) A.C. LOSSES IN SUPERCONDUCTING SYNCHROTRON MAGNETS. Brechna, H.; Ries, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Apr 1971. 11p. (CONF-710308–31). Dep. NTIS (U. S. Sales Only).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

A.C. losses of composite conductors and synchrotron magnets are given. A new equation, based on a skin-effect assumption, is presented which shows that the generally accepted self field calculations yield too high values. Results from loss equations are compared to a few tests on small solenoids. Losses in superconducting coils when exposed to time varying magnetic fields have several origins: Eddy current losses in the conductor matrix, self field, hysteretic and auxiliary losses in the superconducting coils and composite conductors, hysteretic and eddy current losses in the iron return path and eddy current losses in the metallic support structure, reinforcements and containers. As all losses including heat conduction and radiation have to be removed by the coolant, the major effort will be to limit these losses to manageable low values. The results of new investigations are summarized. (auth)

10676 (KHFTI–70-29) EFFECTS OF INTERNAL TARGET ON BEAM DYNAMICS IN A STORAGE RING. Adeishvili, D. I.; Grishaev, I. A.; Kozin, V. P.; Mocheshnikov, N. I.; Tolstoi, A. E.; Shenderovich, A. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

The influence of various targets was studied on the dynamics of a beam in a storage device FTI of the Academy of Sciences, Ukrainian SSR. The lifetime of the beam was investigated as a function of target dimensions, confirming the possibility of an arrangement of physical operations for circulating the beam of the storage device, thus permitting a choice of the required target for various experiments. (tr-auth)

10677 (KHFTI–70-66) PROTON LINEAR ACCELERATOR WITH SMOOTH REGULATION OF ENERGY OF ACCELERATED PARTICLES FROM 3 TO 9 MeV. Rudyak, B. I.; Bomko, V. A.; Klyucharev, A. P. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The characteristics and construction of a variable 3.5- to 9.1-MeV proton linear accelerator are described, and the experimental testing of systems of high frequency supplies is discussed. The accelerator was put into service in 1965. (W.H.K.)

10678 (NP–19092) POWER PULSE TRANSFORMER. Bogdanov, O. S.; Vakhrushin, Yu. P.; Zhitenev, V. G.; Kolesov, N. I.; Orlov, A. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The operation and construction of a powerful pulse transformer, designed for operation in the range of 50 to 500 nsec, are described. A description of the transformer mock-up is given, and results of its testing are presented, which show that the transformer of this type provides good voltage pulse transfer and is characterized by reliable operation. It is recommended to be used in the power supply of the powerful electron gun of the LIA-30/250 accelerator (Linear Induction Accelerator). (auth)

10679 (NP–19137) INJECTION OF A 72-MeV PROTON BEAM IN THE SIN RING CYCLOTRON AND ITS ACCELERATION. Diss. Nr. 4593. Braun, Herbert (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1971. 119p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

The injection of a 72 MeV proton beam into the SIN isochronous ring accelerator can be realized in two different ways: by conventional injection through a magnetic and electrostatic inflector channel, or by precessional injection with a first harmonic field component and without the electric channel. The superposition of the sector field with the field of the magnetic inflector channel produces a stray field which has to be compensated within the short distance of half a gap-width. A general design principle for such a self compensated magnetic channel is given. The acceleration of a beam centered on an equilibrium orbit produces a coherent oscillation. An ideal orbit exists which exhibits only negligible oscillations due to the energy gain. The injection path should be centered on this orbit. The acceleration voltage varies with radius. This causes an alternating magnetic field which influences the phase width of the particle bunch. For small phase angles the phase width varies reciprocally with the accelerating voltage. The crossing of $\nu_r = 4/3$ resonance, driven by the fourth Fourier component of the acceleration voltage, has only negligible influence on beam quality. (auth)

10680 (RHEL/R–233) NIMROD OPERATION AND DEVELOPMENT QUARTERLY REPORT, JULY 1–SEPTEMBER 30, 1971. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Nov 1971. 15p. Dep. NTIS (U. S. Sales Only). UK 20p.

The Nimrod beam was on for High Energy Physics Research for 81.7% of HEP scheduled operating time. Three experiments

commenced and eight continued through in this quarter. Some radiation dosimetry results for the inner vacuum vessel are presented, showing integrated isodose contours at the end of 1970 together with absorbed radiation dose profiles from 1965. The computer control system for the K9 beam line has become operational and some early impressions of the system, which employs interpretive software, are discussed. (auth) (UK)

10681 (TRI-71-1) PROPERTIES OF ION ORBITS IN THE CENTRAL REGION OF A CYCLOTRON. Louis, R. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). Oct 1971. 141p. Dep. NTIS (U. S. Sales Only).

The behaviour of ion orbits in the magnetic and electric fields at the center of a cyclotron is studied in detail. The objective is to optimize the phase acceptance and beam quality for a 500 MeV H^- isochronous cyclotron. Since accurate electric fields are necessary for orbit calculations, a numerical method for calculating those fields is examined in detail. The method is suitable for complicated electrode shapes and converges rapidly, yielding potentials in three dimensions with average errors of less than 0.01%. The magnetic fields used in the orbit calculations are measured on model magnets. The axial motions are examined using a thick lens approximation for the accelerating gaps. A method is demonstrated for calculating the axial acceptance of the cyclotron as a function of RF phase. This method is used to evaluate the merits of various central geometries and injection energies. This method is also used to examine the effects of flat-topping the RF voltage by adding some third harmonic to the fundamental waveform. It is found that addition of the optimum amount of third harmonic increases the phase acceptance by about 20 deg. Finally, the effects of field bumps on the axial motions are investigated. To allow accurate radial motion calculations to high energy, an approximate formula is developed which yields accurate (<1%) values for the changes in orbit properties of an ion crossing a dee gap. The geometry of the orbit on the first turn is discussed in detail. The radial centering is studied by tracking ions from injection to 20 MeV, and a method is described for choosing the starting conditions of the beam so as to minimize the radial betatron amplitude over a desired phase range. The problems associated with using a three-fold symmetric magnetic field with a two-fold symmetric electric field are also discussed. Besides the well-known gap-crossing resonance, a previously ignored phase-oscillation effect is found to be important for cyclotrons operating on a high harmonic of the ion rotation frequency. (auth)

10682 (UCRL-20855) ENHANCEMENT OF LANDAU-DAMPING COEFFICIENTS FOR COLLECTIVE RADIAL INSTABILITIES IN AN ELECTRON-RING ACCELERATOR BY AN ANCILLARY B_ϕ-FIELD. Laslett, L. Jackson; Schumacher, Uwe (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 4p. (CONF-710908-6). Dep. NTIS.

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Attention is directed to the utility of an azimuthal magnetic field for influencing favorably the Landau-damping coefficients that act to suppress transverse collective oscillations in an electron-ring device. Such a supplemental magnetic field can also assist in the attainment of satisfactory betatron-oscillation frequencies. Examples are given of these effects for a (time-dependent) B_ϕ-field applied to an electron-ring compressor similar to the projected LBL Compressor 5 and also to a compressor with high magnetic field index, so that in addition high damping coefficients for longitudinal instabilities are obtained. (auth)

10683 PHYSICS WITH INTERSECTING STORAGE RINGS. Course XLVI of Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy, June 16–26, 1969. Touschek, B. (ed.). New York; Academic Press Inc. (1971). 528p. $27.00.

Separate abstracts were prepared for the 13 chapters presented. (W.H.K.)

For abstracts of individual chapters see: 10382, 10429–10433, 10484, and 10684–10689.

10684 RADIATIVE POLARIZATION OF ELECTRONS IN STORAGE RINGS. Baier, V. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Rend. Scu. Int. Fis. Enrico Fermi; 46: 1-49(1971).

The problem of radiative polarization of electrons and positrons in storage rings is discussed under the following topics: radiative spin-flip transition; kinetics of radiative polarization; depolarization effects; and measurements of electron polarization. (L.B.S.)

10685 ORSAY ELECTRON-POSITRON STORAGE RING (STATUS REPORT). Haissinski, J. (Faculte des Sciences, Orsay, France). Rend. Scu. Int. Fis. Enrico Fermi; 46: 141-55(1971).

A description is given of the Orsay storage ring, its operation, and its present performances. Specific features dealt with are those connected with the beam mean energy, the energy spread of the stored particles, the geometrical structure of the bunches, the interaction rate and its limitation, the filling time and beam lifetime, and the spill-out of stored particles. (L.B.S.)

10686 BUNCH-LENGTHENING EFFECT IN STORAGE RINGS. Lebedev, A. N. (CNEN, Frascati, Italy). Rend. Scu. Int. Fis. Enrico Fermi; 46: 184-93(1971).

The collective longitudinal instabilities inside an rf-bunched beam in a storage ring are studied. Excitations of internal coherent synchrotron oscillations are considered as a possible origin of the bunch lengthening effect. (W.H.K.)

10687 COHERENT INSTABILITIES IN ELECTRON-POSITRON STORAGE RINGS. Pellegrini, C. (CNEN, Frascati, Italy). Rend. Scu. Int. Fis. Enrico Fermi; 46: 221-43(1971).

The principle types of instabilities are described for the case of a single stored beam. The resistive wall and the head-tail instabilities are illustrated, considering a simple model where the beam consists of only one or two particles. The results are extended to the real case of a beam with many particles and many bunches. (L.B.S.)

10688 PHYSICS OF ELECTRON STORAGE RINGS. AN INTRODUCTION. Sands, M. (Univ. of California, Santa Cruz). Rend. Scu. Int. Fis. Enrico Fermi; 46: 257-411(1971).

A review of the basic physical processes that determine the behavior of electron storage rings with a particular concern for their performance as instruments for research in particle physics is presented. Collective effects, two-beam effects, luminosity, beam density luminosity, maximum luminosity, and effective interaction area are reviewed. Also, betatron oscillations, energy oscillations, radiation damping, radiation excitation, and the luminosity of a high-energy storage ring are discussed. (W.H.K.)

10689 SELECTED TOPICS OF BEAM OPTICS RELEVANT TO STORAGE RING DESIGN. Steffen, K. G. (Deutsches Elektronen-Synchroton, Hamburg). Rend. Scu. Int. Fis. Enrico Fermi; 46: 412-52(1971).

Topics include fundamentals of trajectory optics, nondispersive deflecting systems, isochronous deflecting systems, amplitude and phase functions, envelope in terms of generating trajectories, Collin's straight section, 4-dimensional envelope formalism in systems with x-z coupling, closed orbit in a machine with bending field distortions, dispersion (closed orbit for particle with momentum deviation), orbit length and momentum compaction factor, effect of focusing-field distortion on amplitude function and ν-value, resonant excitation of betatron oscillations, magnet lattice and radiation damping, fodo-channel for continuously varying the radiation damping distribution, and low-β insertion. (W.H.K.)

10690 EFFECT OF PHASE OSCILLATIONS ON EMISSION SPECTRUM OF RELATIVISTIC ELECTRONS IN SYNCHROTRONS. Mazmanishvili, A. S.; Naugol'nyi, N. N.; Shenderovich, A. M. (Kharkov Physical-Technical Inst.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 6, 1025-8(Jun 1971). (In Russian).

The radiation spectrum was studied for the general case in which an electron completes a random synchrotron oscillation. The results of the theoretical development indicate a disappearance of "pedestals" of fine structure with elapse of time; the spectral form of the "pedestals" is determined by a specific multiplier. (K.S.W.)

10691 APPLICATIONS OF SUPERCONDUCTIVITY TO ACCELERATOR MAGNETS. Bronca, G.; Neyret, G.; Parain, J.; Perot, J. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 159, 5-15(May 1971). (In French).

Existing and envisaged accelerators are reviewed, and the applications of superconductivity to the 300-GeV CERN synchrotron are discussed. The problems associated with the construction of superconducting dipoles are reviewed with particular emphasis on field precision, coil construction, magnetic shielding, losses, stored energy, and electromagnetic forces. A prototype dipole, currently being constructed, is described. (France)

10692 SUPERCONDUCTORS AND BEAM TRANSPORT. THE DEVELOPMENT OF A DOUBLET WITH A LARGE ACCEPTANCE OPTICS. Bronca, G.; Hamelin, J.; Neel, J.; Parain, J.; Renard, M. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 159, 25-35(May 1971). (In French).

A large number of beam-line coils are used in conjunction with particle accelerators. If superconducting materials are used, the electrical power requirements are diminished, the dimensions are reduced, and the magnetic field is enhanced. Such techniques are foreseen for the several-hundred-GeV accelerators envisaged. The Saturne synchrotron department of the CEN at Saclay is at present constructing a quadrupolar doublet with a large acceptance optics. This doublet, which consists of two independent superconducting devices, will be the first of its type; it will be operational at the beginning of 1972. This doublet will enable

a fourfold increase in the secondary particle flux used in high-energy physics. (France)

10693 MCMASTER'S FN TANDEM ACCELERATOR. McKay, J. (McMaster Univ., Hamilton, Ont.). Can. Res. Develop.; 3: 24-6(Jul-Aug 1970).

In 1970 nuclear research capability was greatly expanded by the startup of an FN-type tandem electrostatic accelerator. This installation is used to generate particle beams of H, D, He, O, C, Cl and S at energies up to 80 MeV. This energy is obtained by using a high voltage terminal (rated at 7.5 MV) and multiple charge exchange. The machine has been pushed to 8.3 MV and is currently being modified to obtain higher voltages and greater energy stability. Construction of the various parts of the device is described briefly. (F.S.A.) (Canada)

10694 STATIONARY STATE OF AN ELECTRON RING IN AN EXTERNAL MAGNETIC FIELD. Budnyam, S.; Zhidkov, E. P.; Ivanov, I. N.; Perel'shtein, E. A. Zh. Vychisl. Mat. i Mat. Fiz.; 11: No. 4, 1043-7(Jul-Aug 1971). (In Russian).

An algorithm is presented for conducting the numerical investigation of the stationary state of a ring of charged particles in an external magnetic field. The mathematical model employed, that of a stationary ring cluster, was due to O. I. Yarkovoi. The function of particle distribution in the phase region was selected in the form of a function of two integral motions. The algorithm obtained may be used to find a self-consistent form for an electron ring with a large particle density with a significant curvature. (K.S.W.)

10695 ISOPROPANOL–SOLID CARBON DIOXIDE COOLED ACCELERATOR TARGET ASSEMBLY. Colle, R. P.; Preiss, I. L. (Renssaeler Polytechnic Inst., Troy, N. Y.). J. Phys., E (London); 4: No. 12, 977-80(Dec 1971).

An efficient accelerator target assembly and cooling system are described. The target assembly consists of a cooled copper jacket with interchangeable targets. The cooling system employs an isopropanol–solid carbon dioxide cooling bath and isopropanol as the coolant. The system is an improvement over conventional water-cooled assemblies and has the advantages of eliminating the need for deionization of the coolant, providing cooling to near 200°K in thick targets, and allowing operation at much higher beam power loadings in thin targets. The target design was evaluated with an electron beam in aluminum and tantalum targets up to power loadings of 2 kW cm^{-2}. (auth)

10696 ELECTRON AND ION BEAM SCIENCE AND TECHNOLOGY. Fourth International Conference, Los Angeles, California, May 10–15, 1970. Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970). 677p. (CONF-700546).

Thirty-nine papers are included which discuss both theoretical advances and industrially adopted innovations in the electron and ion beam field. They are arranged into four sections: beam physics and related topics, welding and materials processing, micro electronics, and irradiation processing. Separate abstracts have been prepared for 16 of the papers. One paper had been previously abstracted in NSA (see NSA 25: 11356). (D.L.C.)

For abstracts of individual papers see: 9155, 9711–9713, 9823, 9924–9926, 10068, 10269–10271, 10697, and 10698–10700.

10697 INVESTIGATION OF A LASER-IRRADIATED ELECTRON SOURCE. Andelfinger, C.; Buechl, K.; Buchelt, E.; Ott, W.; Siller, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 3-7 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

A 2-MeV electron source giving a current of 400 A with a maximum emittance of 50 mrad-cm was desired. The beam of a Q-switched ruby laser was focused on a Ta plate, and a voltage up to 60 kV was applied between the plate and the collector electrode. A delay line was used to prevent short-circuiting between the plate and collector. The height of the electron current pulses increases with laser energy in the focus and depends on the beam spot size also. Pulses with amplitude up to 1000 A were obtained with good focusing. Brightness of the $\frac{1}{2}$ and $\frac{1}{4}$ of the maximum phase density were determined to be 10×10^{-2} and 3×10^{-2} A/sterad-cm^2-eV, respectively. (D.L.C.)

10698 IONIZATION PHENOMENA INSIDE A DUOPLASMATRON EXPANSION CUP. Bex, L.; Bernard, P. (CEN, Saclay, France). pp 68-86 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

It was desired to design an intense pulsed polarized proton or deuteron source. The current can be increased to a few tens μA by using the expansion cup of a duoplasmatron as an ionizer. The ionization phenomena occurring inside the expansion cup are analyzed. Experimental observations were taken using helium; results show the presence of H^+ impurities. (D.L.C.)

10699 CESIUM ION SOURCE WITH LARGE PERVEANCE AND HIGH DEGREE OF COLLIMATION. Meyer, Rudolf X. (Aerospace Corp., El Segundo, Calif.). pp 87-102 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

A Cs ion source is described in which the ions are accelerated in a negative space-charge sheath produced by a filament. A magnetic field parallel to the ionizer surface is produced by two pole pieces. Experimental results on a prototype give current densities from 4 to 14 mA/cm^2 and a large perveance up to 2.2×10^{-6} A/$V^{\frac{3}{2}}$ per module. The beam divergence was ~1.5°. The collisionless electron and ion motions in the space-charge sheath region are analyzed, and ion and electron current densities, particle trajectories, and electric potential distribution are computed. (D.L.C.)

10700 PRODUCTION OF HEAVY IONS USING THE PLASMA JET FROM A DUOPLASMATRON SOURCE. Warnecke, R.; Richardt, A. pp 103-12 of Electron and Ion Beam Science and Technology. /Bakish, Robert (ed.). New York; Electrochemical Society, Inc. (1970).

From fourth international conference on electron and ion beam science and technology; Los Angeles, Calif. (10 May 1970).

The ion source consists of a duoplasmatron and a high-temperature furnace. This furnace is heated by electron bombardment using electrons extracted from the helium plasma generated by the duoplasmatron. As a result, the source proper never sees the metallic ions and thus has a long contaminant-free life. Among first results, 100 μA of boron ions were obtained for 100 hours of continuous operation. (auth)

10701 ELEKTROFIZICHESKAYA APPARATURA. SBORNIK STATEI. VYPUSK 8. (Electrophysical Apparatus (Collection of Articles). Number 8). Moscow; Atomizdat (1969). 176p.

This collection consists of twenty-one papers on problems, calculations, and equipment in development of accelerators, MHD generators, and plasma injectors. In one paper asymmetric hf oscillations in toroidal resonators with capacitive disks, used in accumulators, are investigated. In several papers, questions associated with the design and investigation of high-current linear accelerators of resonance type, isochronous cyclotrons, and electrostatic and cascade generators are examined. Power supplies for accelerators, as well as systems for stabilization and automatic regulation, are discussed. Finally, problems related to pulsed supplies for linear high-frequency and induction accelerators are treated. (tr-auth)

10702 ION SOURCE WITH A UNIFORM RADIAL DENSITY. Bex, Lucien; Faure, Jean; Vienet, Roger (to Commissariat a l'Energie Atomique). French Patent 2,061,809. 1 Jun 1971. Filed 4 Apr 1969. (In French).

An ion source with a quasi-uniform radial density is described. This source consists of an ionization chamber in which the gas to be ionized is introduced, a cathode located at the center of an intermediate electrode possessing an orifice through which the electrons pass, an anode with a hole through which the ions pass, an electrode, electrically insulated from the anode and negative with respect to it which controls the expansion of the plasma, and an ion extraction electrode. The internal surface of the expansion controlling electrode may be covered with a Au layer to avoid unwanted polarization; the (negative) potential of this electrode may be equal to that of the intermediate electrode. (France)

10703 DESIGN CRITERIA OF LINACS FOR SPECTRUM AND INSTABILITIES OF ELECTRON ENERGY. Irie, Koichi (Mitsubishi Electric Corp., Amagasaki, Japan). Jap. J. Appl. Phys.; 11: No. 1, 69-75(Jan 1972).

Design criteria for spectrum and instabilities of electron energy are given with the accelerating structure of the phase velocity equal to the light velocity. The broadening of energy spectrum is due to energy difference of electrons during a pulse and phase shift of electrons along the accelerating structure. For usual S-band linacs of 2 meters long operated in $2\pi/3$ mode, tolerances necessary to limit the broadening of energy spectrum within 5% are: klystron beam-voltage irregularities below 1.2%, RF frequency irregularities below 2.1×10^{-5}, temperature deviation and gradient of the accelerating structure below 1.3 degrees and 2.0 degrees, respectively, dimensional errors of the accelerating structure below 0.014 mm, and the beam loading irregularities below 5%. These are discussed theoretically and some of them are compared with the experimental values. (auth)

10704 TRANSIENT AND STATIONARY TEMPERATURE RISE OF THE ACCELERATING STRUCTURE IN ELECTRON

LINACS. Irie, Koichi (Mitsubishi Electric Corp., Amagasaki, Japan). Jap. J. Appl. Phys.; 11: No. 1, 76-81(Jan 1972).

Temperature equations which describe temperature distribution along the accelerating structure as a function of time are solved in some special but practical cases on traveling wave electron linacs. The time constant of temperature rise of the accelerating structure is about 20 seconds and the saturated temperature rise is about 2°C in usual S-band linacs for radiography and medical therapy. Also the temperature gradient along the accelerating structure is discussed and its effects on performances of electron linacs are shown to be little. (auth)

10705 HIGH-VACUUM ION SOURCES. Zinchenko, G. N.; Zinchenko, N. S. (Kharkov State Univ. Inst. of Radio Physics and Electronics, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1057-70(Jul 1971). (In Russian).

Papers on high-vacuum ion sources are reviewed. The classification of the known sources is presented according to their ionization and principal parameters characterizing different types and variants of such sources. On the basis of the actual data, the different types of sources are compared; the advantages and drawbacks of some types and variants are discussed. To have a complete comparative estimation of different source types, two additional parameters are suggested: the source perveance and the luminosity. It is shown that this introduction facilitates the choice of the necessary type and variant of the source for various technical applications. (auth)

10706 SEALING MECHANISMS IN UHV VALVES: A CONTRIBUTION TO THE DESIGN. Wikberg, T. (European Organization for Nuclear Research, Geneva). Vacuum; 21: No. 8, 337-42(Aug 1971).

The construction of the vacuum chamber for the Intersecting Storage Rings at CERN has created, among other requirements, the need for a large number of special UHV valves. This concerns, in particular, the remote operation of the valves and the possibility of baking in closed position. Most commercially available UHV valves are manually operated, and the flow of the seal materials must be compensated by an increase of the valve stroke or even by applying gradually higher sealing forces. This has been overcome by a new design approach. (auth)

10707 BETATRON AND ITS MEDICAL APPLICATION. Szirmai, E.; Royl, P. (Univ., Stuttgart). Acta Med. Okayama; 24: No. 2, 237-47(Apr 1970).

As a radiation source for fast electrons and hard gamma-rays one uses the betatron, which was developed by Kerst in 1941 after preliminary work of Slepian, Walton, Wideröe and Steendeck. The intensities available from the betatron for β-therapy are much higher than those for gamma therapy. The gamma rays of the 35-MeV betatron have an intensity of about 100 R/min. For the same operating conditions the β-rays have an intensity of 1000 R/min. The depth for the maximum effect of the irradiation can be changed by variation of the β-energy only in the case of β-irradiation, since the available intensities increase with the third power of the β-energy. Irradiation with bremsstrahlung below the maximum energy would not be very effective since the gamma intensities have only 10% of the value of the β-intensity. But betatrons which operate at a higher frequency than 50 cycles (Allis-Chalmers 25-MeV betatron) have higher intensities. By irradiation with high dose rates (some 100 R/min) the therapy time gets very small (some minutes). From the medical point of view the β-irradiation is more tissue-compatible, because radiation diseases of the skin do not result so often. If there are some radiation diseases on the skin, they heal much faster than those from x-rays. Deeper-lying tumors can be treated optimally since the particle energies are very high. (The rate of survival and the healing prospects are better than those from other radiation therapies.) Within some limits one can choose the depth for the maximum effect of the β-irradiation by variation of the particle energies. By use of a collimating device and an equalizing compound the electrons from the betatron can be collimated and their intensity can be homogenized. By this one gets very good local irradiation effect. (Japan)

10708 INTENSE NEUTRON GENERATOR AND FUTURE FACTORY TYPE ION ACCELERATORS. Lewis, W. Bennett (Atomic Energy of Canada, Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 28-35 (Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The status of factory type ion accelerators for neutron production is reviewed, and the prospects of developing and using ion drag accelerators are discussed. (W.H.K.)

10709 INSTRUMENTATION FOR MONITORING CURRENT FROM A 30 MeV ELECTRON LINAC. Paul, D. A. L.; Horrigan, E. W.; Kisly, M.; Lam, D. K.; Madsimov, J. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 96-102(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Non-intercepting magnetic induction monitors for measuring the total current or charge passing down the electron drift tubes have been constructed which are suitable for electron pulses from about 50 nanoseconds to 3.5 microseconds in width. Measurements are derived from output signals which are tuned to frequencies in the range 250 to 45 kHz. Alternatively, for viewing pulse envelopes, ferrite coil outputs are integrated by a 25 ohm termination. The monitors are calibrated using an air cooled Faraday cup which is described. (auth)

10710 LINAC BEAM LOSS DETECTION SYSTEM USING SELF-POWERED DETECTORS. Hewitt, J. S.; Horrigan, E. W. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 103-6(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A beam loss detection system employing self-powered gamma detectors to monitor the radiation produced by stray beam has been installed on the 35 MeV linac. The system enables the operator to optimize machine and beam transport parameters to a precision not possible using conventional monitors alone. (auth)

10711 DATA ACQUISITION COMPUTER WITH FOREGROUND–BACKGROUND OPERATING SYSTEM. Goodman, Charles D. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 136-41 (Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

An on-line data acquisition computer system is described which runs background computational programs while it is acquiring data independently of and asynchronously with the program. A combination of hardware and software prevents loss of data and destruction of the system through errors in Fortran background programs. The system described was designed for ORIC. (auth)

10712 USE OF A SIGMA-7 IN A NUCLEAR PHYSICS LABORATORY. Benenson, W.; deForest, R. A.; Au, R. F.; Bayer, D. L.; Merritt, W. E. (Michigan State Univ., East Lansin). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 145-6(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Advanced features of the Scientific Data Systems Sigma-7 computer are being used at the Michigan State University Cyclotron Laboratory to produce a system which meets all of the needs of the laboratory. The computer is capable of large off-line tasks such as distorted wave Born approximation calculations and large on-line jobs such as 16K channel pulse height analysis and particle identification. Several off-line jobs can be time-shared with safe real-time operation using a supervisor program called JANUS. (auth)

10713 DEVICE FOR MEASURING THE POSITION, SIZE, AND INTENSITY OF HIGH-ENERGY PARTICLES. De Parry, Theodore (to United States Atomic Energy Commission). U. S. Patent 3,612,858. 12 Oct 1971. Filed 10 Feb 1970.

A particle-beam position monitor includes first and second pairs of plates mounted normal with respect to the longitudinal axis of the particle beam on opposite sides thereof. The associated plates of each of the first and second pairs are spatially mounted with respect to each other, and each has one edge positioned to lie in a single plane parallel to the longitudinal axis of the particle beam. Two voltage sources are connected to produce potentials between the associated plates of the first and second pairs, and a pair of electrometers measures secondary electron emission from the pairs of plates in the presence of the particle beam. A bridge circuit differentially combines the measured secondary electron emission to provide a relative measure of the position of the particle beam. (auth)

10714 PROPERTIES OF ION ORBITS IN THE CENTRAL REGION OF A CYCLOTRON. Louis, Robert John. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.

Thesis.

The behavior of ion orbits in the magnetic and electric fields at the center of a cyclotron is studied in detail. The objective is to optimize the phase acceptance and beam quality for a 500 MeV H^- isochronous cyclotron. Since accurate electric fields are necessary for orbit calculations, a numerical method for calculating these fields is examined in detail. The method is suitable for complicated electrode shapes and converges rapidly, yielding potentials in three dimensions with average errors of less than

0.01%. The magnetic fields used in the orbit calculations are measured on model magnets. The axial motions are examined using a thick lens approximation for the accelerating gaps. A method is demonstrated for calculating the axial acceptance of the cyclotron as a function of RF phase. This method is used to evaluate the merits of various central geometries and injection energies. This method is also used to examine the effects of flat-topping the RF voltage by adding some third harmonic to the fundamental waveform. It is found that addition of the optimum amount of third harmonic increases the phase acceptance by about 20 deg. Finally, the effects of field bumps on the axial motions are investigated. To allow accurate radial motion calculations to high energy, an approximate formula is developed which yields accurate (<1%) values for the changes in orbit properties of an ion crossing a dee gap. The geometry of the orbit on the first turn is discussed in detail. The radial centering is studied by tracking ions from injection to 20 MeV, and a method is described for choosing the starting conditions of the beam to minimize the radial betatron amplitude over a desired phase range. The problems associated with using a three-fold symmetric magnetic field with a two-fold symmetric electric field are also discussed. Besides the well-known gap-crossing resonance, a previously ignored phase-oscillation effect is found to be important for cyclotrons operating on a high harmonic of the ion rotation frequency. (Diss. Abstr. Int., B)

10715 IMPROVEMENTS IN OR RELATING TO PARTICLE ACCELERATORS. Poole, Michael John; McCann, John David (to United Kingdom Atomic Energy Authority). British Patent 1,255,472. 1 Dec 1971. Filed 28 Nov 1967.

A beam exit window system for a particle accelerator is described including an inner window to the vacuum system and an outer window providing a protective shield for the inner window. Since the pressure differential across the outer window can be zero it can be extremely thin, so as to have a minimum effect on a beam of particles passing through. The inner window is gas cooled and an enclosure is provided for constraining the cooling gas to remain in the vicinity of the window. Pumping means are provided to cause the cooling gas to flow through the enclosure, and the enclosure has a window aligned with, and fixed relative to, the gas cooled window, and the interior of the enclosure communicates with the ambient atmosphere. The pumping means may supply cooling gas to the interior of the enclosure, or may extract cooling gas in order to induce flow through the enclosure. In the latter case the cooling gas is supplied to the interior of the enclosure at atmospheric pressure and the extraction rate adjusted so that the gas in the enclosure is below atmospheric pressure; in this way the pressure differential across the gas cooled window can be reduced without putting undue strain on the outer window. The cooling gas may be air. (UK)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 9419, 10253, 10353, 10665, 10708, 10901, and 11393.

10716 (DP–1276) TESTING OF ENDF/B–THERMOS CROSS SECTIONS FOR H_2O, D_2O, C, ZrH_2, $(C_2H_4)_x$, Be, BeO, C_6H_6, AND UO_2. McCrosson, F. J.; Finch, D. R.; Olson, E. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct 1971. Contract AT(07-2)-1. 46p. (ENDF–158). Dep. NTIS.

Multiple temperature THERMOS multigroup cross sections were generated from the ENDF/B thermal neutron scattering data for light and heavy water, graphite, zirconium hydride, polyethylene, beryllium and beryllium oxide, benzene, and uranium dioxide using the FLANGE II processing code. No major inconsistencies were uncovered in the THERMOS cross sections, which were tested by comparisons with literature values of the total neutron cross section (σ_T), the average cosine of the scattering angle ($\bar{\mu}$), and the thermal diffusion parameters (D_0 and C). (auth)

10717 (IAE–2027) ANALYSIS OF EXPERIMENTS ON NEUTRON THERMALIZATION IN THE GRAPHITE–WATER SYSTEM. Mostovoi, V. I.; Trukhanov, G. Ya.; Safin, Yu. A.; Moskovkin, V. N. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 28p. (In Russian). INIS.

The space–energy distribution of neutrons was analyzed by time of flight at various points in a graphite–H_2O system at high temperatures. A comparison with a multigroup calculation was made using a kinetic equation. The method of deriving the first relaxation line and the rethermalization line from experimental data is briefly described. These lines are presented for graphite and water at several temperatures of graphite. (INIS)

10718 (JINR–E14–5987) TRIAL EXPERIMENTS ON THE MAGNON SCATTERING OF NEUTRONS AT THE IBR BEAM NO. 1A. Krasnitski, S.; Vanits, A.; Baiorek, A.; Balanda, M.; Domoslavski, Ya.; Natkanets, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 19p. Dep. NTIS (U. S. Sales Only).

Magnon inelastic scattering of neutrons on Cr_2O_3 powder and Fe_7S_8 single crystal samples was measured. This was performed using two methods: 1) the single-crystal analyzing technique and 2) the inverted Be filter analyzing technique. In both cases magnon peaks were observed. The usefulness of the IBR reactor beam for such kind of experiments is proved. (auth)

10719 (JUL–776–FF) PROBLEM OF THE FERMI APPROXIMATION FOR THE SCATTERING OF THERMAL NEUTRONS. Dietze, H.-D.; Nowak, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). Jun 1971. 57p. (In German). Dep. NTIS (U. S. Sales Only).

One consequent development of the scattering length with respect to the binding potential of the nucleus is given and applied as an example nuclei up to the second approximation. In the approximation with respect to the binding potential the results of the T-operator theory in the formal scattering theory, as developed in recent years, were used. In the present T-operator theory matrix elements outside the energy shell are necessary. The formal scattering theory in the present study takes in a relatively wide range, whereby the given derivation of the T-operator from the spectral representation of the scattering operator is new and permits a very direct development of the T-operator theory. Numerical results are given only for the limiting case of vanishing neutron energy and the ground state in the oscillator potential of the bound nucleus. (tr-auth)

10720 (LCA-NT–171–ET) EVALUATION OF NEUTRON SPECTRA IN WATER USING THE MONTE CARLO METHOD. Fiegel, Arsene (Laboratoire Central de l'Armement, Arcueil (France)). 31 Mar 1971. 33p. (In French). Dep. NTIS (U. S. Sales Only).

A Monte Carlo method used for calculating neutron spectrum produced in water by an Am–Be point source is described; this source is situated at the center of a 25 cm radius sphere full of water. The sphere is coated with a paraffin wax layer. The spectrum is compared with that deduced from recoil proton track measurements. (France)

10721 (N–71–28119) METHOD FOR PRODUCING MONOENERGETIC NEUTRONS AT KILOVOLT ENERGIES. Binney, Stephen E.; Amster, Harvey; Henninger, Rudolph J.; Mark, Hans (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jun 1971. 11p. (NASA-TM-X-2296). NTIS.

A new method is presented for producing neutrons in the keV energy region which utilizes gamma rays from the radioactive decay of a single isotope to induce the photoneutron reaction in beryllium. The neutrons have as many different energies as there are gamma ray energies above the 1.665-MeV threshold energy of this reaction. For the gamma ray emitters chosen, the neutrons were nearly monoenergetic, although sometimes bienergetic. The gamma ray emitters were steadily formed by neutron activation in an aqueous solution circulated through a nuclear reactor. After leaving an irradiation reservoir near the reactor core, the activated solution flowed over the exterior surface of a thin spherical shell of beryllium, where the photoneutrons were produced. Near the center of the shell, the neutron flux was nearly time-independent and isotropic; the effects of multiple scatterings by all materials were calculated by a one-dimensional multigroup transport code. In order to generate a variety of neutron spectra, the sulfates of manganese, indium, and aluminum were used in separate experiments. Fluxes of the order of 10,000 to 1,000,000 neutrons/sq cm sec can be obtained by this method. (auth) (STAR)

10722 (N–71–30298) SOLUTION OF AN INITIAL-VALUE PROBLEM IN LINEAR TRANSPORT THEORY: MONOENERGETIC NEUTRONS IN A SLAB WITH INFINITE REFLECTORS. Newman, Perry A.; Bowden, Robert L. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). May 1971. 115p. (NASA-TR-R–357; L–7208). NTIS.

Thesis. Submitted by Perry A. Newman to Virginia Polytechnic Inst., Blacksburg.

The solution of an initial-value problem in linear transport theory is obtained by using the normal-mode expansion technique of Case. The problem is that of monoenergetic neutrons migrating in a thin slab surrounded by infinitely thick reflectors and the scattering is taken to be isotropic. The results obtained indicate that the reflector may give rise to a branch-cut integral term typical of a semi-infinite medium whereas the central slab may contribute a summation over discrete residue terms. Exact expressions are obtained for these discrete time eigenvalues, and numerical results showing the behavior of real time eigenvalues as a function of the material properties of the slab and reflector are presented. These eigenvalues are finite in number and may disappear into the branch cut or continuum as the material properties are varied; such disappearing eigenvalues correspond to exponentially time-decaying modes. The two largest eigenvalues can be compared with critical dimensions of slabs and spheres, and the numerical values are shown to agree with the criticality results of others. In the limit of purely absorbing reflectors or a bare slab, the present solution has the same properties as have been previously reported by others who used the approach of Lehner and Wing. (auth) (STAR)

10723 (NP–19091) INVESTIGATION OF THE NEUTRON ENERGY SPECTRUM IN THE LOWER eV REGION BY A SCATTER PEEL–OFF METHOD. Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1971. 83p. (In German). Dep. NTIS (U. S. Sales Only).

A newly developed "scatter peel-off method" is described for investigations of the neutron energy spectrum in the lower eV-region and measurements are reported. This out-of-pile method utilizes the energy loss-scattering angle relation which governs the elastic neutron-hydrogen scattering. The differentiation of the angle-dependent reaction rate measured behind the scatterer by a cadmium covered ^{3}He-detector yields the structure of the neutron spectrum from the cut-off energy of cadmium near 0.6 eV up to an energy of about 50 eV, which is the limit set by the resolution of the device. The theoretical fundamentals are explained, the device is described and related problems are discussed. First measurements performed on a 1/E-spectrum, which was modified by known absorbers, showed the usefulness of this method. Further measurements performed on a hard spectrum were compared with measurements of resonance foils. (auth)

10724 (ORNL–TM–3585) COLLISION SITE PLOTTING ROUTINES AND COLLISION DENSITY FLUENCE ESTIMATES FOR THE MORSE MONTE CARLO CODE. Straker, E. A.; Emmett, M. B. (Oak Ridge National Lab., Tenn.). 4 Oct 1971. 125p. Dep. NTIS.

Routines for use with the Monte Carlo transport code MORSE have been written to provide collision site plots — that is, plots of the locations of collisions occurring during the random walk process. The plots can be made either on the on-line printer or, through a collision tape, on a pen and ink or cathode-ray plotter. The user must decide what type of events and over what spatial range the collisions are to be plotted. Also, an output routine

has been added to take advantage of the collision counter information in MORSE in providing a region-averaged estimate of the fluence. Printer plots of the resulting energy spectra for both neutrons and gamma rays are part of the output. This output may be obtained for both forward and adjoint calculations. These routines can also be utilized in other Monte Carlo codes. (auth)

10725 (RD/B/M-2058) DATA FOR THE CALCULATION OF GAMMA RADIATION SPECTRA FROM FISSION FRAGMENTS (REVISION 1). Davies, B. S. J.; Tobias, A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Aug 1971. 122p. Dep. NTIS (U. S. Sales Only).

A complete set of available data on the properties of the fission products of ^{235}U, ^{238}U, ^{239}Pu and ^{241}Pu is presented. The compilation covers fission yield, half-life, gamma radiation energy and intensity, and thermal neutron cross-section, for fission chains of mass number 72 to 161. The gamma radiation spectrum is given as the number of photons per 100 disintegrations in each of a set of 10 keV-wide bands. (auth) (UK)

10726 (SRARI-P-90) APPLICATION OF THE ADAMS METHOD TO THE NEUTRON MODERATION PROBLEM IN A HOMOGENEOUS INFINITE MEDIUM. Platonov, A. P. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 16p. (In Russian). INIS.

The application of Adams' method to the problem of neutron distribution according to energies during their moderation in an infinite, homogeneous single-component medium is described. It is then possible to obtain different formulas which assure a high degree of accuracy. (tr-auth)

10727 EQUIVALENCE OF THREE KINETIC METHODS FOR CALCULATING THE SPACE-TIME CORRELATION FUNCTION. Chihara, Junzo; Sasaki, Ken; Obata, Yukio (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 31: No. 5, 3123-8(Nov 1971).

It is shown that three kinetic methods [(i) initial-value approach, (ii) dielectric approach and (iii) method of fluctuations in distribution function] for calculating the space-time correlation function using the Vlasov-Boltzmann equation are equivalent to one another, provided that the effective potential in the kinetic equation is proportional to the direct correlation function. This same condition brings the exact zeroth and second moments of the dynamic structure factor $S(Q,\omega)$ obtained by the kinetic method. These moment sum rules are independent of the collision term. (auth)

10728 MEASUREMENT OF THE SLOWING DOWN TIME TO 0.3 eV IN BERYLLIUM OXIDE. Rainbow, M. T. (Univ. of Tasmania, Hobart, Australia); Ritchie, A. I. M. J. Nucl. Energy; 25: No. 10, 461-78(Oct 1971).

The reaction rates of ^{239}Pu and boron (1/v) were measured as a function of space and time in a large block of beryllium oxide following the injection of a pulse of fast neutrons. The time dependent reaction rates associated with the various Fourier spatial modes were derived from the experimental results. The experimental value of the peaking time of the ^{239}Pu reaction rate associated with the fundamental spatial mode was found to be 19.85 ± 1.1 μsec. A theoretical value of 16.5 μsec was obtained using a time dependent zero-dimensional diffusion code and a crystal scattering kernel for beryllium oxide. It was in marked disagreement with the experimental value. Measurements made of the time to peak in the ^{239}Pu reaction rate as a function of distance from the source showed a total variation of 4 μsec in peaking time over a distance of 52.8 cm. Theoretical calculations of the peaking time as a function of distance showed a similar variation and the general trends were in good agreement with the experimental result. There was, however, a constant discrepancy between the theoretical and experimental results of the order of that noted for the fundamental mode. (auth) (UK)

10729 SOURCE OF LOW ENERGY NEUTRONS. (to National Nuclear Corp.). British Patent 1,252,119. 3 Nov 1971. Priority date 3 Sep 1969, United States.

A compact, self-contained neutron source providing low-energy neutrons from $Li(\alpha,n)$ reactions is described. The source consists of a stainless steel sealed can containing a mixture of lithium hydride and plutonium dioxide powders. (J.W.R.)

10730 NEUTRON BRANCHING PROCESSES. Mori, Takakazu (Kyoto Sangyo Univ.); Watanabe, Shinzo; Yamada, Toshio. Publ. Res. Inst. Math. Sci.; 7: No. 1, 153-79(Jul 1971).

The neutron transport process is formulated as a continuous-time branching process. The asymptotic properties of the neutron population in such a formulation are studied. (J.W.R.)

10731 VARIATION OF NEUTRON FLUX IN SMALL SYSTEMS BY TIME-DEPENDENT P_3 APPROXIMATION. Hishida, Hisashi (Mitsubishi Atomic Power Industries, Inc., Tokyo). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 30, 19-27(Sep 1970). (In Japanese).

The time variation of neutron flux in a small rectangular system was obtained by the P_3 approximation of Boltzmann's transport equation. The results were compared with properties of eigenvalues and eigenfunctions calculated by diffusion approximation, using the size of the system and the absorption cross section as parameters. The equation was solved under boundary conditions that the value of an asymptotic term of neutron flux is zero at extrapolated end points, and that the flux satisfies Marshak's free surface condition at the surface. The results were compared with experimental data for a non-moderating system of fast neutrons measured by Beghian et al. Variation of sensitivity of a detector due to moderation effect was ignored, and it was assumed that the fast neutrons were cutoff by a energy selection channel because of energy loss. The time-dependent P_3 approximation was in good agreement with the experimental results whereas the diffusion approximation deviated in the case of small systems. (Japan)

10732 BASE OF TRANSPORT THEORY. Kuze, Hironobu (Tokyo Metropolitan Univ.). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 31, 23-33(Nov 1970). (In Japanese).

An attempt to express transportation of particle density with a quantum mechanical density operator was carried out. This method has also been applied to analyze photon and electron transportation. Application of the method to neutron transportation was carried out in this paper. It is necessary to include generation and extinction of neutrons in the theory. These phenomena are usually expressed with generation and extinction operators when a group of particles is in steady state. The present problem is to find proper operators for calculation of expected values. The operators should be density operators. Ono's choice for the operators (Prog. Theor. Phys., Kyoto 12 (1954) 113) was employed. Properties of the operators under unitary transformations were investigated. Single and double density operators for neutrons were selected. Relations to be satisfied by the operators were introduced. Finally, equations representing neutron transport in a reactor were introduced. Particle density instead of neutron flux was used in these equations. Swaying and noise were dealt with analytically. (Japan)

10733 THEORY OF THERMAL NEUTRON SCATTERING. THE USE OF NEUTRONS FOR THE INVESTIGATION OF CONDENSED MATTER. Marshall, W.; Lovesey, S. W. International Series of Monographs on Physics. Oxford; Clarendon Press (1971). 622p. £12.

The subject is discussed under the following headings; elementary theory, nuclear Bragg scattering, correlation functions in nuclear scattering, scattering by phonons, scattering by magnetic interactions, magnetic scattering by salts: theory, elastic magnetic scattering, correlation functions in magnetic scattering, scattering by spin waves, polarization analysis, neutron scattering from liquids, scattering by gases, critical magnetic scattering, magnetic diffuse elastic scattering from alloys, and inelastic defect scattering. (UK)

10734 AVERAGE AND EFFECTIVE ENERGIES, AND FLUENCE-DOSE EQUIVALENT CONVERSION FACTORS FOR ^{239}Pu-Be, ^{241}Am-Li, AND ^{241}Am-F NEUTRON SOURCES. Ro, Seung Gy; Yoo, Young Soo (Atomic Energy Research Inst., Seoul). J. Korean Nucl. Soc.; 3: No. 3, 155-60(Sep 1971).

Average and effective energies for ^{239}Pu-Be, ^{241}Am-Li and ^{241}Am-F neutron sources have been calculated from a number of published data for the neutron spectra and for the dose equivalent as a function of neutron energies by a numerical method. Also a calculation of the dose equivalent conversion factors, i.e., the first collision dose equivalent and the surface (or multicollision) dose equivalent that equals the product of surface-absorbed dose and a corresponding quality factor, per unit fluence of neutrons from these sources has been carried out. (auth)

10735 POSITIVE DIFFERENCE SCHEMES IN NEUTRON SPECTRAL CODES. Kulikowska, Teresa (Inst. of Nuclear Research, Swierk, Poland). Nucl. Sci. Eng.; 46: No. 2, 317-20 (Nov 1971).

A new finite difference scheme assuring positivity of solutions in spectral codes based upon the Greuling-Goertzel approximation is developed. The method can be adopted in any code of this type without changing the execution time and storage requirements. The method has been applied in the Algol version of the BIGG code and found advantageous in the case of comparatively wide lethargy intervals when the standard central difference formulas could lead to instabilities. (auth)

10736 NEW DIFFERENCE SCHEMES FOR THE NEUTRON TRANSPORT EQUATION. Reed, William H. (Los Alamos

Scientific Lab., N. Mex.). Nucl. Sci. Eng.: 46: No. 2, 309-14 (Nov 1971).

Three new difference schemes for solving the neutron transport equation are presented. In some situations these new methods give smoother results than the diamond difference scheme, without sacrificing second-order accuracy. Iteration schemes for solving the new difference equations are given, and convergence acceleration devices are discussed. Numerical results illustrate the behavior of these new schemes in a variety of situations. (auth)

10737 NUMERICAL DETERMINATION OF THE DISCRETE PART OF THE SPECTRUM OF EIGENVALUES OF THE NEUTRON TRANSPORT EQUATION BY MEANS OF APPROXIMATION OF A MEASURED CURVE. Aleksandrov, L. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 211-21(1971). (In Bulgarian).

In the case of a pulsed source, the solution of the neutron transport equation has the form $N = \Sigma_h c_h e^{-bt}$. The purpose of the present paper is the numerical finding of the coefficients c_h and indices h by means of approximation of a measured curve. The mathematical correctness of the problem is considered, and stable numerical algorithms for constructing the solution are offered. One of them is realized in the program VFZ for an electronic computer. An example is given for reconstruction of the neutron decay function by means of the VFZ program.

10738 PASSAGE OF REACTOR NEUTRONS THROUGH AN IRON–PARAFFIN FILTER WITH AIR CAVITY. Khristov, V.; Stanolov, A. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 117-23(1971). (In Bulgarian).

The spatial and energy distribution of the neutrons from the reactor is studied for their transmission through an iron–paraffin filter with an air cavity, placed in one of the horizontal channels of the IRT reactor in Sofia. It is shown that the air cavity acts as a peculiar thermal column increasing 2.53 times the mean value of the thermal neutron flux in it in comparison with the mean value of the flux in a long air channel. The spatial distribution of the resonance and fast neutrons in the cavity significantly deviates from the $1/x^2$ law; this deviation leads to an increase of the relaxation lengths of the neutrons with these energies. The measurements show that the cavity does not introduce noticeable changes in the spectral distribution of the resonance neutrons. (auth)

10739 TRANSMISSION OF REACTOR-SPECTRUM NEUTRONS THROUGH TWO-LAYER IRON–PARAFFIN FILTERS. Stanolov, A. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 99-108(1971). (In Bulgarian).

By means of a set of 13 activation detectors the space-energy distribution of resonance neutrons in the energy interval from 0.46 to 5800 eV and fast neutrons with an effective threshold over 2.78 MeV is investigated for their transmission through a 15-cm iron filter and air cylinder with a length 140 cm and through a two-layer iron–paraffin filter with a total length 57 cm (15 cm iron and 42 cm paraffin). The investigations were carried out in one of the horizontal experimental channels of the IRT reactor in Sofia. The relaxation lengths of these filters are determined for the transmission of neutrons with resonance energies 0.46, 1.46, 4.95, 20 to 50, 73, 132, 580, and 1900 eV and of the fast neutrons with energies over 2.78 MeV. It is shown that the iron–paraffin filter decreases the number of the resonance neutrons 4 to 6 times and of the fast neutrons about 10 times in comparison with the effect of the iron–air filter. The data obtained concerning the space-energy variation of the reactor neutron flux will be useful for equipping the experimental channels for carrying out radiobiological and neutron-physics investigations. (auth)

10740 NEUTRON WAVE INTERFERENCE EFFECTS IN BERYLLIUM OXIDE. Word, J.; Lawrence, E. W. (Queen Mary Coll., London). J. Nucl. Energy: 25: No. 10, 525-9(Oct 1971).

The problem of neutron wave interference in a moderator is investigated by examination of the energy dependence, using a realistic scattering kernel and transport cross section to represent the moderator. The theory is based on a (complex) eigenfunction expansion method. Results, which are for a BeO system at 21°C, $B_\perp^2 = 0.00483\ cm^{-2}$, clearly show that interference can occur. (UK)

10741 NEUTRON GENERATOR. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,252,375. 3 Nov 1971. Priority date 21 Dec 1968, Germany.

A neutron generator with an ion source at high voltage arranged inside a vacuum housing is described. Neutrons are produced by nuclear reactions of an ion beam with a target. This neutron generator is versatile in use, and can be economically adapted to very different purposes. (R.W.R.)

10742 BACK-REFLECTION OF NEUTRONS FROM MOSAIC CRYSTALS. Hiismaeki, P. (Helsinki Univ. of Tech., Ontaniemi, Finland). Acta Polytech. Scand., Phys. Nucl. Ser.: No. 70, 1-36 (1970).

For calculating the transmission and reflection probabilities of neutrons impinging on mosaic crystals normal to a set of lattice planes, a new technique has been developed based on the invariant imbedding approach for solving the underlying monoenergetic transport equation of strongly angle-dependent scattering cross-sections. The initial value problem resulting has been solved numerically with a digital computer for the (111)-reflection of Al. The results of the calculations have been compared to an experimental curve measured with a thermal-expansion-shifted back-reflection spectrometer described in detail. An average size of coherently scattering regions equal to about 8×10^9 unit cells was found to be in best agreement with the width of the measured curve. Possible reasons for the discrepancy between the depths of the experimental and calculated curves are discussed. (auth) (Finland)

10743 PECULIARITY OF THE FINITE DIFFERENCE SOLUTION OF THE BOLTZMANN EQUATION. Rumyantsev, G. Ya. At. Energy. (USSR); 31: No. 5, 514-15(Nov 1971). (In Russian).

Analytical methods of neutron transport theory have been successfully used to investigate an accurate transport equation. The method of discrete ordinates was used as an example of an analytical solution of a Boltzmann equation in plane geometry. (K.S.W.)

10744 TIME DECAY OF NEUTRON PULSES IN FAST SUBCRITICAL ASSEMBLIES. Adalioglu, Ulvi. Ann Arbor, Mich.; Univ. of Michigan (1971). 108p. University Microfilms Order No. 71-23,685.

Thesis.

The time behavior of a neutron pulse in a subcritical fast multiplying assembly are investigated. In particular, the time decay constants characterizing such a process are investigated by analyzing the time eigenvalue spectrum of the transport operator for fast neutrons in an arbitrary, non-reentrant geometry. To simplify this analysis, isotropic scattering was assumed and a simple model of inelastic scattering due to Okrent was employed. By applying the techniques of functional analysis familiar from the study of the time eigenvalue problem for thermal neutrons, it has been possible to classify the spectrum of the transport operator into the usual band spectrum for $\mathrm{Re}\{s\} \leq -\lambda^*$ where λ^* is the minimum collision frequency and a point spectrum for $\mathrm{Re}\{s\} > -\lambda^*$. It was demonstrated that this point spectrum was void for either sufficiently small assembly sizes or sufficiently small concentrations of fissile material. The results of this general study were confirmed by simplified models which approximated both the spatial dependence (e.g., diffusion theory or asymptotic reactor theory) and the scattering kernel (e.g., ignoring elastic slowing down and modeling inelastic scattering). In particular, the dispersion laws for several models were studied analytically and found to agree with the more general, but formal, functional analysis. Such dispersion law analyses were found to depend sensitively upon the value of λ^*. For $v \in [0,\infty)$, λ^* occurs for very low neutron energies ($E \ll 1$ eV). However, in fast assembly, the number of neutrons with E less than several keV is quite small. Hence several models were developed which employed a cutoff speed range $v \in [v_c,\infty)$ and hence a more realistic value for λ^*. By choosing correspondingly truncated inelastic scattering and fission spectra, a model was constructed which agreed with the more general results of the functional analysis and yet avoided the unrealistic dependence upon low energy neutrons. This model was studied in some detail for very far subcritical assemblies in which a true exponential decay was absent. Using the familiar analytic continuation techniques, it was possible to isolate an intermediate time "pseudo-exponential" time decay as well as to analyze the very long time behavior. Numerical calculations based upon this model were performed for a typical iron-^{235}U assembly, and such analysis was in qualitative agreement with experimental measurements performed on subcritical fast assemblies. (Diss. Abstr. Int., B)

10745 HIGH SPACE MODE ANALYSIS OF A LARGE CYLINDRICAL PULSED H_2O SYSTEM. Hollis, Harold David. Rolla, Mo.; Univ. of Missouri (1970). 77p. University Microfilms Order No. 71-22,372.

Thesis.

By utilizing a geometrically centered pulsed source internal to a large ($B_g^2 \simeq 0.002$) cylindrical H_2O system, the neutron flux was measured as a function of position and time. A least square fit of the data yielded the fundamental and five higher decay constants and amplitudes of the thermal neutron flux. Symmetrical and enhanced neutron densities were obtained as a result of the internal source. Long waiting times were unnecessary and data acquisition was accelerated. The decay constants were found to be independent of position, pulse width, counting time and rates, method of nor-

malization, or waiting time. The decay constants were related to the bucklings by an analysis of the amplitudes without variance of the size of the system. This method gives $\Sigma_a v = (4759 \pm 54)\ sec^{-1}$, $D_0 = (3.7084 \pm 0.0897) \times 10^4\ cm^2/sec$, $L = (2.79 \pm 0.05)$ cm, $\sigma_a^H = (323 \pm 3)$ mb, and a mean neutron lifetime of (210 ± 2.4) μsec. (Diss. Abstr. Int., B)

10746 REVIEW OF MATHEMATICAL THEORY OF NEUTRON TRANSPORT EQUATIONS. Ukai, Seiji; Nishihara, Hiroshi (Kyoto Univ.). Nippon Genshiryoku Gakkaishi; 13: No. 2, 76-84 (Feb 1971). (In Japanese).

A brief summary of neutron transport theory, limited to spectral theory, exact solutions, and approximate treatment of transport equations, is presented. The first part covers spectral-theoretic studies of initial-value problems. The spectrum of neutron wave propagation and the relaxation length of neutron diffusion is not discussed. Next, various analytical methods of solving steady-state problems are described, most of which are a direct outgrowth of the well-known Case method. Finally, the mathematical theory of finite difference methods for deriving approximate solutions of the transport equation is summarized, with emphasis on convergence and stability. (auth)

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Refer also to abstracts 10778, 10811, 10899, and 10943–10945.

10747 (IAE–2059) CONSERVATION OF LEPTON CHARGE IN BETA-DECAY PROCESSES. Borovoi, A. A.; Plis, Yu. A.; Khodel, V. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

A survey was made of data on the conservation of lepton charge in β-decay processes. The experimental search for neutrino-free two-fold β-decay is discussed and nuclear matrix elements of this process are evaluated. Reverse β-processes which are forbidden by the law of lepton conservation are described. Experiments involving possible nonconservation of leptons are evaluated. (tr-auth)

10748 (NYO–4032-64) TRITON CALCULATIONS WITH PHASE EQUIVALENT NUCLEON–NUCLEON INTERACTIONS. Hadjimichael, E.; Jackson, A. D. (State Univ. of New York, Stony Brook). [1971]. 17p. Dep. NTIS.

M. Haftel and F. Tabakin have recently generated a series of potentials by applying a unitary transformation to the Reid potential. The new potentials have a short-range non-locality but reproduce exactly the two-body (bound-state) observables calculated with the Reid potential. Several of these potentials were used to calculate the triton binding energy, RMS radius, S-, D- and S'-state admixture probability and charge form factor. These triton observables are sensitive to the short-range part of the nucleon-nucleon interaction, and it is concluded that the triton can be used confidently to test phenomenological and field-theoretically derived models of the short-range portion of the nucleon-nucleon interaction. (auth)

10749 (ORNL-TM-3616) REPORT TO THE AEC NUCLEAR CROSS SECTION ADVISORY COMMITTEE. Good, W. M. (Oak Ridge National Lab., Tenn.). Oct 1971. 50p. Dep. NTIS.

This memo is a collection of brief reports on recent and not yet generally publicized work at ORNL which is of special interest to the NCSAC. Included are abstracts of relevant ORNL reports, and papers which have been only submitted for publication. The memo covers the period of time since the last NCSAC meeting. (auth)

10750 LOW-ENERGY SCATTERING OF ^{3}He AND ^{4}He FROM A POLARIZED ^{3}He GAS TARGET. Boykin, Wilber Ray. Houston, Tex.; Rice Univ. (1971). 144p. University Microfilms Order No. 71-26,261.

Thesis.

Experimental asymmetries in ^{3}He and ^{4}He scattered from a ^{3}He gas target polarized by the method of optical pumping have been measured for the bombarding energy range of 4.33 to 9.83 MeV. The reactions observed were: $^3\vec{He}(^4He,^4He)^3He$ at $\theta_{cm} = 71.6°$; $^3\vec{He}(^4He,^3He)^4He$ at $\theta_{cm} = 120.0°$, $^3\vec{He}(^3He,^3He)^3He$ at $\theta_{cm} = 60.0°$, and $^3\vec{He}(^3He,p)^5Li$ (ground state) at $\theta_{lab} = 30.0°$. A phase shift analysis of existing ^{3}He–^{4}He elastic scattering data has been performed with particular attention to assigning errors to the phase shifts. A single level parameterization of the p-wave phase shifts using R-matrix theory has given reasonable values of the nuclear reaction radius and ratio of reduced width to Wigner limit for the $^2P_{\frac{3}{2}}$ and $^2P_{\frac{1}{2}}$ states in ^{7}Be. (Diss. Abstr. Int., B)

10751 APPROXIMATE SOLUTION OF A STURM–LIOUVILLE SYSTEM USING NONORTHOGONAL EXPANSIONS: APPLICATION TO $\alpha-\alpha$ NUCLEAR SCATTERING. Chatwin, R. A.; Purcell, J. E. (Florida State Univ., Tallahassee). J. Math. Phys. (N. Y.); 12: No. 9, 2024-30(Sep 1971).

A stationary principle for the Sturm–Liouville system with inhomogeneous boundary conditions leads to an approximate solution in which nonorthogonal expansions are used. It is shown that if the nonorthogonal functions are chosen to be the eigenfunctions of a similar Sturm–Liouville equation, then the numerical solution of the boundary value problem no longer involves an integration of a second derivative, but only the more simple integration of a function. As an illustration, formulas for calculating the nuclear phase shifts of a Schrödinger equation with a long-range Coulomb potential are presented in the notation of R-matrix theory. The numerical convergence of the method is investigated for $\alpha-\alpha$ nuclear scattering from real potentials that have a repulsive core followed by a short-range attraction (Ali and Bodmer). Generalizations of the method have been applied in nuclear physics to coupled differential equations and to eigenvalue problems. (auth)

10752 (n,d) REACTIONS ON LIGHT NUCLEI. Miljanic, D.; Valkovic, V. (Institut Rudjer Boskovic, Zagreb). Nucl. Phys.; A176: No. 1, 110-28(1971).

A survey of (n,d) reactions on ^{3}He, ^{6}Li, ^{7}Li, ^{10}B, ^{11}B, ^{14}N, ^{15}N, ^{16}O and ^{19}F is made using zero-range DWBA calculations. Average parameters for the neutron and deuteron optical-model potentials are used. The spectroscopic factors obtained from this analysis are compared with theoretical predictions as well as with the results from other one-nucleon transfer reactions on these nuclei. In most cases reasonable agreement between theoretical predictions and experimental data is achieved. Strong disagreement for (n,d) reaction on ^{6}Li is associated with the presence of reaction mechanisms other than proton pick-up. (auth)

10753 CALCULATION OF N–d SCATTERING WITH S-, P-, AND D-WAVE FORCES. Pieper, S. C. (Case Western Reserve Univ., Cleveland). Phys. Rev. Lett.; 27: No. 25, 1738-40(20 Dec 1971).

A two-potential formalism based on the equations of Alt, Grassberger, and Sanhas [Nucl. Phys., B2: 167(1967)] is used to generate elastic nucleon–deuteron scattering amplitudes by combing P- and D-wave nucleon–nucleon forces in first order with "exact" nucleon–deuteron scattering amplitudes for S-wave forces. Elastic differential cross sections at 14.1 MeV and nucleon polarizations at 10.04, 14.1, and 22.7 MeV are presented. The cross sections are very accurate while the polarizations are in qualitative agreement with experiment except at 22.7 MeV. (auth)

10754 EFFECT OF APPROXIMATE WAVE FUNCTIONS IN COMPOSITE PARTICLE SCATTERING. Lavan, Michael John. Iowa City, Iowa; Univ. of Iowa (1971). 108p. University Microfilms Order No. 71-22,055.

Thesis.

Many investigators have studied the scattering of low-energy nucleons by light nuclei using a single particle effective potential which is derived from a many-nucleon Hamiltonian, under the assumption that the contribution to the scattering of virtual excitations of the target nucleus can be neglected. In addition, they approximated the ground state wave functions of the target nuclei by crude variational wave functions, thus introducing an unknown error into the results of the scattering calculation. The error for the specific case of neutron-triton scattering is investigated. To do this three approximate effective potentials are derived which differ from each other, and from the exact single particle effective potential, by the same order in the error of the approximate triton wave function. The difference between the phase shifts calculated with the approximate potentials gives an indication of the uncertainty in the calculations, and as the approximate triton wave function is improved the difference decreases. The work shows that previous calculations involve large uncertainties which may be reduced by improving the approximate target wave function. (Diss. Abstr. Int., B)

10755 VARIATIONAL–ITERATIONAL CALCULATION OF THREE-NUCLEON BINDING ENERGY. Antonchenko, V. Ya.; Simenog, I. V. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1071-6(Jul 1971). (In Russian).

The wave functions of the strong-coupling-constant method, presented as a series in inverse powers of the coupling constant, are used as test functions to calculate two- and three-nucleon ground-state energies. An analysis of the energy dependence on the approximation order of the function was made for some simple paired potentials. A simple interpretation is suggested for the variational parameters; the mean square radius and form factors of three-particle nuclei are calculated. (auth)

10756 $^{2}H(^{3}He,\gamma)^{5}Li$ REACTION FROM 2- TO 26-MeV. King, H. T.; Meyerhof, W. E.; Hirko, R. G. (Stanford Univ., Calif.). Nucl. Phys.; A178: No. 2, 337-49(1972).

The $^{2}H(^{3}He,\gamma)^{5}Li$ cross section has been measured at 90° for ^{3}He energies of 2 to 26 MeV, corresponding to excitation energies in ^{5}Li of 17 to 26 MeV. Gamma-ray angular distributions were measured at several energies in this range. Transition intensities to the ground state (γ_0) and first excited state (γ_1) of ^{5}Li were extracted, and the γ_0 results were compared to theoretical predictions. The γ_0 and γ_1 results were found to be consistent with a $^{1}/_{2}^{+}$ state near 18 MeV and a $^{5}/_{2}^{+}$ state near 21 MeV in ^{5}Li. Evidence was also found for higher-lying states, some of which might have negative parity. (auth)

10757 DIFFERENTIAL CROSS SECTION AND THE ANALYZING POWERS iT_{11}, T_{20}, T_{21}, AND T_{22} OF THE REACTION $^{3}He(\vec{d},p)^{4}He$ BETWEEN 2.8 AND 11.5 MeV. Grueebler, W.; Koenig, V.; Ruh, A.; and others. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A176: No. 3, 631-44(1971).

The differential cross section $\sigma_0(\theta)$ and the analyzing powers $iT_{11}(\theta)$, $T_{20}(\theta)$, $T_{21}(\theta)$ and $T_{22}(\theta)$ of the reaction $^{3}He(d,p)^{4}He$ have been measured for 7 energies between 2.8 MeV and 11.5 MeV at lab angles between 0° and 160°. The results were fitted with Legendre polynomials. The energy dependence of the resulting Legendre coefficients indicates resonance-like behavior at energies corresponding to excitations of 16.6 MeV, 17.5 MeV, 20.0 MeV, 20.9 MeV and 22.4 MeV in ^{5}Li. The reaction $^{3}He(d,p)^{4}He$ is an excellent analyzer for deuteron vector and tensor polarization when specific angles for the different analyzing power are chosen. (auth)

10758 EFFECT OF TWO-PION-EXCHANGE THREE-BODY FORCE IN TRITON. Yip, P. C.-Y. Nogami, Y.; Ross, C. K. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A176: No. 3, 505-12(1971).

The contribution of the two-pion-exchange three-body force to the binding energy of the triton is examined. An effective two-body force due to the three-body force in the triton is derived, and used in combination with the Hamada–Johnston two-body force. The results depend on the pionic form factor which was introduced in deriving the three-body force. Without the form factor, the contribution to the triton binding energy is found to be about 1 MeV attraction. Using the same form factors as were used in similar calculations for nuclear matter, however, the contribution is reduced to about 0.3 MeV attraction. (auth)

10759 EXCHANGE MAGNETIC FORM FACTOR OF ^{3}He AND ^{3}H. Kloet, W. M.; Tjon, J. A. (Univ., Utrecht). Nucl. Phys.; A176: No. 3, 481-8(1971).

The contribution to the exchange magnetic form factors of ^{3}He and ^{3}H from two of the important diagrams is calculated for realistic wave functions such as for the Reid potential. It is found that the exchange magnetic moment depends little on the type of wave function used. The q^2 dependence for small q^2, where q is the photon momentum, shows a spatial extension of the exchange magnetic moment density, due to these terms, that is considerably less than that of the nucleons. This will make the square radius of the total density decrease with a few percent. (auth)

10760 IMAGINARY POTENTIAL IN RESONATING-GROUP CALCULATION OF $^{3}He + ^{3}He$ SCATTERING. Brown, Ronald E. (Univ. of Minnesota, Minneapolis); Reichstein, I.; Tang, Y. C. Nucl. Phys.; A178: No. 1, 145-54(1971).

The $^{3}He + ^{3}He$ differential scattering and reaction cross-section data in the energy range of 1.5 to 15 MeV (c.m.) are analyzed with a one-channel resonating-group method to which is added a phenomenological imaginary potential in order to account approximately for open reaction channels. With a nucleon–nucleon potential of near-Serber exchange mixture it is found that satisfactory results can be obtained with such a formalism. The presence of the imaginary potential is shown to be important, especially at higher energies; it affects the magnitude of the differential cross section mainly, but can also accentuate the diffraction features at certain energies. (auth)

10761 DWBA TREATMENT OF THE REACTION $^{3}He(d,tp)p$. Charlton, L. A.; Kelso, S. M.; Warner, R. E. (Oberlin College, Ohio). Nucl. Phys.; A178: No. 1, 39-48(1971).

The cross section for the reaction $^{3}He(d,tp)p$ was calculated using distorted waves for the d–^{3}He, t–pp, and p–p relative motions; it was assumed that the final triton interacted with the p–p c.m. The shapes of observed t–p coincidence spectra were well reproduced for low p–p relative energies, and the magnitudes were usually correct within a factor of 3. (auth)

10762 OFF-SHELL SPECTATOR MODEL FOR d(p,2p)n. McCarthy, I. E.; Tandy, P. C. (Flinders Univ. of South Australia, Bedford Park). Nucl. Phys.; A178: No. 1, 1-8(1971).

The quasi-free peak for the reaction d(p,2p)n is examined in the off-shell spectator approximation at incident energies from 14.4 MeV to 100 MeV with the use of the Hamada–Johnston potential. At all these energies it is essentially indistinguishable from the on-shell (impulse) approximation, which gives correct shapes but overestimates the magnitudes of differential cross sections due to lack of unitarity. Theoretical interest in the approximation lies in its possible use as a starting point for improved approximations. The energy at which partial waves higher than the s wave in the pp system are important is investigated. As a result of the Coulomb interference, the amplitude in this approximation for the (n,2n) quasi-free peak is larger than that for the (p,2p) peak at the same energy by an approximate scale factor; this finding simplifies the possibility of using these reactions to investigate charge symmetry. (auth)

10763 INVESTIGATION OF THE REACTION $^{3}H(n,2n)^{2}H$ AT E_n = 13.95 MeV AND THE NEUTRON–NEUTRON SCATTERING LENGTH. Adam, G.; Bar Avraham, E.; Fox, R.; Porat, Y. (Technion-Israel Inst. of Tech., Haifa, Israel). Nucl. Phys.; A178: No. 1, 321-31(1971).

The reaction $^{3}H(n,2n)^{2}H$ was investigated theoretically and experimentally, with particular emphasis on its relation to the n–n scattering length. It was found that the deduced n–n scattering length depends sensitively on the choice of the triton wave function and its size. (auth)

10764 QUASIFREE PROTON–PROTON SCATTERING ON ^{3}He. Frascaria, R.; Comparat, V.; Marty, N.; (and others) (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A178: No. 1, 307-320(1971).

Quasi-free proton–proton scattering cross sections in the $^{3}He(p,2p)^{2}H$ reaction were measured at 155 MeV incident energy for low momenta of the recoiling deuteron, and are compared with theoretical calculations in the DWIA for different ^{3}He radial wave functions. The results are very sensitive to the radial form of the wave functions, and the best agreement is obtained with an exponential wave function with short-range correlations. (auth)

10765 BINDING ENERGIES FOR THE TRITON AND α-PARTICLE USING THE REFERENCE SPECTRUM METHOD. Tripathi, Ram K. (Univ. of Kentucky, Lexington). Nucl. Phys.; A178: No. 1, 257-62(1971).

The reference-spectrum method is applied to calculate the binding energies of ^{3}H and ^{4}He for the momentum-dependent interactions of Nester et al [Nucl. Phys., A113: 14(1968)]. The results are in good agreement with a perturbation calculation and with experiment. (auth)

10766 NUCLEAR DISPERSIVE CONTRIBUTIONS TO LOW-ENERGY ELASTIC ELECTRON SCATTERING. Bottino, A.; Ciocchetti, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nucl. Phys.; A178: No. 2, 593-611(1972).

A model-independent (low-energy) analysis of the elastic electron scattering by light nuclei is presented with the purpose of establishing the importance of the nonstatic contributions in the experimental determination of rms radii. These dispersive corrections are given in terms of dipole-photoabsorption cross sections. Accurate numerical results are presented for deuterium and helium. (auth)

10767 BACKWARD ELECTRON–DEUTERON SCATTERING BELOW 280 MeV. Ganichot, D. (Ecole Normale Superieure, Orsay, France); Grossetete, B.; Isabelle, D. B. Nucl. Phys.; A178: No. 2, 545-62(1972).

The elastic and inelastic scattering of electrons by deuterium was measured at 180° for four incident energies (70, 140, 210 and 280 MeV). The data were analyzed with a technique allowing an accurate comparison between experiment and theory. A good agreement was observed for the inelastic data with the expected cross section, using the presently available models and nucleon form factors. The experimental elastic cross section is systematically larger than the predicted cross sections. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 10747, 10749, 10752, 10822, 10839, 10844, 10861, 10864, 10870–10872, 10923, 10943–10946, 10995, 11017, 11025, and 11043.

10768 (DESY–71/55) QUASI-ELASTIC SCATTERING (e,e'd) AND (e,e'p) FROM ^{6}Li. Heimlich, F. H.; Roessle, E.; Koebberling, M.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 10p. Dep. NTIS (U. S. Sales Only).

Electrons of 2.7 GeV have been scattered from ^{6}Li and detected at 13.8 and 15.0°, in coincidence with outgoing protons and deuterons, kinematically corresponding to quasifree scattering (momentum-transfers 10.5 and 12.2 fm^{-2}). Electron-proton and -deuteron spectra, angular distributions and momentum spectra of the recoil nucleus are presented. (auth)

10769 (FRNC-TH-100) COMPOUND NUCLEUS RESONANCES AND THE DIRECT INTERACTION IN d + ^{12}C REACTIONS. Berrada, Mohamed (Bordeaux Univ. (France)). 1971. 99p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The angular distributions in the ^{12}C(d,d$_0$), ^{12}C(d,p$_0$), ^{12}C(d,p$_1$) ^{13}C*(3.09 MeV), ^{12}C(d,p$_2$)^{13}C**(3.68 MeV), ^{12}C(d,p$_3$)^{13}C***(3.86 MeV) reactions about the 4$^-$ and 3$^+$ resonances of the compound ^{14}N nucleus which occur at E$_d$ = 2.50 MeV and 2.72 MeV were studied. In addition the angular distribution in the more complicated region around 3 MeV, which involves at least two closely separated levels, was investigated. The competing, direct and resonant, mechanisms were studied. The contributions due to the direct interaction, resonant interaction, and mixed interactions were estimated. Very particular results occur at the E$_d$ = 2.50 MeV resonance for the p$_2$ group: a form characteristic of stripping is found on each side of the base of the resonance peak; the peak itself corresponds to a process involving the compound nucleus with a very high symmetry relative to 90 deg. (France)

10770 (IAE–2039) NEW DIRECT NUCLEAR REACTION (^{6}Li,t) AND (^{6}Li,^{3}He). Davydov, V. V.; Novatskii, B. G.; Ogloblin, A. A.; Sakuta, S. B.; Stepanov, D. N.; Timofeev, V. A.; Chuev, V. I. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The (^{6}Li,t) reaction was investigated for the nuclei ^{9}Be, ^{12}C, and ^{13}C, and the (^{6}Li, ^{3}He) reaction was studied in connection with a ^{12}C nucleus in the ^{6}Li energy range 23.8 to 31.0 MeV. Two basic mechanisms were realized in such reactions: a ter-nucleon transfer, and some unique mechanism associated with the transfer of nucleus-target α-particles. The mechanism of transfer of cluster-triton or of ^{3}He was not identified. (tr-auth)

10771 (LBL–234) MASSES OF LIGHT NUCLEI FAR FROM STABILITY. Cerny, Joseph (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 16p. (CONF-710931–1). Dep. NTIS.

From fourth international conference on atomic masses and fundamental constants; Teddington, England (6 Sep 1971).

Mass determination of light nuclei far from the valley of beta stability is discussed. The emphasis is on high-isospin nuclei with masses $5 \leq A \leq 40$; only nuclei that are at least three nucleons away from stable isotopes are considered. Mass excesses for these nuclei are given and compared with theoretical predictions. (R.W.R.)

10772 (LBL–253) SYSTEMATICS OF THE DIRECT (p,α) REACTION. Maples, Creve Cowen Jr. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 191p. Dep. NTIS.

Thesis.

The (p,α) reaction was investigated on ^{16}O, ^{15}N, ^{14}N, ^{13}C, and ^{12}C targets at proton energies between 43.7 and 54.1 MeV. Levels were examined in the residual nuclei up to a maximum of from 15 to 22 MeV in excitation and angular distributions were obtained to approximately 90° c.m. The reaction was found to proceed predominantly via a direct pickup mechanism and to strongly populate only levels consistent with this mechanism. The angular distributions exhibited a strong dependence on the value(s) of J, the total angular momentum transfer. For a given J, the shapes of the distributions were relatively uniform and reasonably independent of kinematic effects. The (p,α) reaction was also observed to preferentially populate higher spin levels. As a consequence of these properties a number of p-shell levels were identified, some of which were previously unreported, and spin and parity assignments were made. The experimental results were found to be in excellent agreement with the general expectations of theory. The DWBA calculations, assuming a triton transfer, were able to predict a pronounced J-dependence in the (p,α) reaction which, at forward angles (θc.m. < 70°) was both consistent and uniform. The results of these calculations reproduced the qualitative features of the angular distributions although, in general, the predictions displayed a more rapid decrease in the cross section with angle than was observed. The effect of non-local and finite-range corrections to the calculations was examined but was found to be unimportant. (auth)

10773 (LUSY–7002) EXPERIMENTAL CROSS SECTIONS FOR PHOTOPROTON EMISSION FROM NUCLEI IRRADIATED WITH 400-MeV BREMSSTRAHLUNG. 1. ANGULAR DISTRIBUTIONS FROM Li AND Be. Dougan, P.; Stiefler, W. (Lund Univ. (Sweden). Dept. of Physics). Jun 1970. 18p. Dep. NTIS (U. S. Sales Only).

Photo-proton emission from Li and Be nuclei irradiated with bremsstrahlung of 400 MeV end-point energy was investigated. Cross sections are listed. (GN) (Sweden)

10774 (LUSY–7003) EXPERIMENTAL CROSS-SECTIONS FOR PHOTO-PROTON EMISSION FROM NUCLEI IRRADIATED WITH 400 MeV BREMSSTRAHLUNG. 2. ANGULAR DISTRIBUTIONS FROM C AND Al. Dougan, P.; Stiefler, W. (Lund Univ. (Sweden). Dept. of Physics). Sep 1970. 20p. Dep. NTIS (U. S. Sales Only).

Photo-proton emission from C and Al nuclei irradiated with bremsstrahlung of 400 MeV end-point energy was investigated. Cross sections are listed. (GN) (Sweden)

10775 (LYCEN–7130) STUDY OF ^{15}O EXCITED STATES BETWEEN 10 AND 10,5 MeV. Chambon, B.; Diallo, O.; Lambert, M.; Madjar, N.; Pastor, C.; Vidal, J. L. (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1971. 31p. (In French). Dep. NTIS (U. S. Sales Only).

The elastic scattering of protons by ^{14}N was studied in the energy range 3 to 3.55 MeV. Four resonances were observed at E$_p$ = 3.209, 3.215, 3.410 and 3.440 MeV. Their widths are respectively $\Gamma = 3 \pm 1$, 11 ± 2, 25 ± 5, 140 ± 40 keV. They correspond to the following excited states of ^{15}O: 10.286, 10.292, 10.474 and 10.502 MeV, whose spins are probably: $5/2^-$, $5/2^+$, $3/2^-$ and $3/2^+$. (France)

10776 (LYCEN–7143) 8,92-MeV DOUBLET OF ^{15}O. Lambert, M.; Bersillon, O.; Chambon, B.; Drain, D.; Vidal, J-L. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 11p. (In French). Dep. NTIS (U. S. Sales Only).

Evidence is presented for the existence of an unresolved energy level doublet at 8.92 MeV in ^{15}O with widths of 3.5 and 9 keV and J$^\pi$ values of $(1/2)^-$, $5/2^+$. (France)

10777 (SAL–18) INELASTIC ELECTRON SCATTERING FROM ^{16}O. Kim, Jong Chan (Saskatchewan Univ., Saskatoon. Saskatchewan Accelerator Lab.). Jan 1971. 116p.

Thesis.

The 140-MeV Saskatchewan electron linear accelerator was used to measure inelastic electron scattering cross sections in oxygen-16. The low-lying levels, e.g. 11.52 MeV (2^+, T = 0), 12.05 MeV (0^+, T = 0), 12.53 MeV (2^-, T = 0), 12.96 MeV (2^-, T = 1) and 13.10 MeV (1^-, T = 1) were studied in this experiment. The transition matrix elements for these levels obtained in the momentum transfer range $0.2 < q^2 < 0.9$ fm^{-2} are derived from the experimental cross section in the first Born approximation. The above momentum transfer range bridges the gap between the data obtained by Bishop et al. at high q and the data of the low q region taken by Stroetzel. With an improved resolution, the 12.96 MeV and 13.10 MeV levels were resolved. Also the longitudinal and transverse components of transition matrix elements were separated. Use of a gas target, operating at low pressure enabled an upper limit to be set on the magnetic monopole (0^-) level at 12.07 MeV as well as showing the finely resolved level structure in the 13 MeV region. The ground state radiative widths were determined by extrapolation to low momentum transfer and compared with previous results obtained by both electron scattering and other experiments. The odd parity states are compared with the particle-hole model predictions generated from Gillet's wave functions. For the even parity levels, as has been already pointed out by others (Seaborn and Eisenberg) the pure shell model description in a spherical well does not fit the experimental data. The generalized Helm model, which is a collective model fitted 11.5 MeV (2^+) level fairly well. The form factor for this level obtained from the Brown and Green wave functions in the SU3 limit has a good diffraction minimum but the magnitude is five times too small. However, it is expected to yield almost the right size when the potential is triaxially deformed as was found for the 12.02 MeV (0^+) level by Gerace and Sparrow (1970). (auth)

10778 (UCRL–50400(Vol.10)) TABULATED EXPERIMENTAL DATA FOR NEUTRON-INDUCED REACTIONS. Perkins, S. T.; Howerton, R. J. (California Univ., Livermore. Lawrence Livermore Lab.). 15 Jun 1971. Contract W-7405-eng-48. 8p. Dep. NTIS $25.00.

Included as part of this report is seven reels of 16 mm film.

The LLL compilation of experimental neutron cross section data is stored in a computer-oriented system. There is given

on six reels of microfilm the 770,000 tabulated data points that were in the system as of June 15, 1971, and on a seventh reel the appropriate bibliographic and data indexes. (auth)

10779 NEGATIVE-PION CAPTURE IN CLOSED-SHELL NUCLEI. Banerjee, B. (Tata Inst. of Fundamental Research, Bombay). Indian J. Phys.; 43: No. 12, 746-53(Dec 1969).

The capture of bound π^- mesons by closed shell nuclei is calculated using the phenomenological Hamiltonian of Eckstein. Numerical calculations are carried out for ^{16}O and the results compared with experiments. (auth)

10780 RATE OF ENERGY LOSS AND NEUTRON YIELD FOR PROTONS ON THICK LITHIUM TARGETS AT ENERGIES FROM 3 TO 10 MeV. Scott, Malcolm C. (Univ. of Birmingham, Eng.). J. Nucl. Energy; 25: No. 9, 405-15(Sep 1971).

A continuous-flow manganese bath was used to measure the neutron yield per unit current from a thick lithium target under proton bombardment, over a proton energy range from 3–10 MeV and to an accuracy of 2–3%. The results at low energy were analysed to provide information on the rate of energy loss of protons in lithium, dE/dx, while those at high energy were used to estimate the cross-section for neutron production by multibody break-up of ^7Li. (auth)

10781 MULTIPOLE ANALYSIS OF FAST-NUCLEON SCATTERING BY NUCLEI. Sitenko, A. G.; Dotsenko, I. S.; Fursa, A. D. (Inst. of Theoretical Physics, Kiev. Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 555-73(Apr 1971). (In Russian).

To describe the high-energy nucleon scattering by nuclei a multipole formalism is developed. The impulse approximation is used. The cross section of the nucleon scattering by nucleus is expressed through the amplitude of the nucleon scattering by a separate nucleon and form factors connected with the nucleus structure. The structural form factors represent the moduli squares of the reduced matrix elements from the multipole moments of the nucleus. With due regard for the charge freedom degrees of nucleons the nucleus can be described by the multipoles of sixteen types with the given multipolarity. Strictly definite selection rules correspond to each transition of the definite multipolarity. The form factors describing the elastic scattering are considered in detail and their connection with the main parameters of the nucleus is determined. The selection rules and character of angular dependence for various transitions with inelastic scattering and phenomena of re-charging are considered. As an example the numerical calculations of angular distributions are presented for elastic proton scattering by ^{12}C nuclei as well as for inelastic proton scattering with the excitation of levels 2^+, 3^- and 1^+ with T = 0 and 1^+ with T = 1 of ^{12}O nucleus. The proton energy was put equal to 185 MeV. The two-nucleon amplitude is chosen according to the experimental data of nucleon scattering by free nucleons. The comparison with the experimental data is fulfilled. The character of angular dependences agrees with the experimental ones, however the absolute value of the cross sections proved to be overstated, which is connected with using of the plane-wave approximation. (auth)

10782 ANALOGUES OF GIANT RESONANCES AND PHOTOPRODUCTION OF POSITIVE PIONS FROM ^{16}O. Rao, K. Srinivasa (Inst. of Mathematical Sciences, Madras). J. Phys., A (London): 4: No. 6, 928-33(Nov 1971).

Using a pure configuration shell model, differential and total cross sections were evaluated for the photoproduction of positive pions from ^{16}O leading to giant resonance states of various multipolarities in ^{16}N. The two-particle–two-hole (2p–2h) ground state correlations in ^{16}O are also taken into account. These 2p–2h correlations reduce the cross sections by about 30%. The total cross section for the 2^+ giant quadrupole state is found to have a large peak near the first pion–nucleon resonance region, making it thereby possible to experimentally identify it from other multipole resonance states by varying the incident photon energy. (auth) (UK)

10783 STUDY OF THE NUCLEAR LEVELS OF ^{18}F USING THE $^{17}O(d,n)^{18}F$ REACTION. Ardouin, D.; Uzureau, J.; Tamisier, R.; Rosier, L. H.; Avignon, P. (Univ., Nantes, France). Compt. Rend., Ser. B; 273: No. 13, 561-4(27 Sep 1971). (In French).

The $^{17}O(d,n)^{18}F$ reaction was studied at 4 MeV. The DWBA formalism allowed the spins and parities of different levels of ^{18}Fe to be determined up to 5.29 MeV. (France)

10784 STUDY OF THE LOWEST KNOWN 6^+ STATE IN ^{16}O BY MEANS OF THE $^{12}C(\alpha,\alpha)^{12}C$ REACTION. Ramirez, J. J.; Bernstein, E. M. (Western Michigan Univ., Kalamazoo). Nucl. Phys.; A173: No. 1, 207-15(1971).

Differential cross-section angular distributions and excitation functions have been measured for the $^{12}C(\alpha,\alpha)^{12}C$ reaction between 10.0 and 10.3 MeV α-particle energies. A strong anomaly is observed near $E_\alpha = 10.2$ MeV at all angles except where $P_6(\cos\theta) = 0$. A phase-shift analysis of the angular distributions indicates a 6^+ resonance. The results of an R-matrix analysis using a single-level formalism yields $J^\pi = 6^+$, $E_{res} = 10.199$ MeV, $\Gamma_{lab} = 70 \pm 10$ keV, and $\Gamma_\alpha/\Gamma = 0.50 \pm 0.03$. Possible configurations for this state are discussed. (auth)

10785 ENERGY LEVELS OF LIGHT NUCLEI A = 16 AND 17. Ajzenberg-Selove, F. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys.; A166: 1-139(1971).

Compilation of energy levels of A = 16 and 17 nuclei is given, with emphasis on material leading to information about the structure of the A = 16–17 systems. (auth)

10786 ISOSPIN NONCONSERVATION IN THE REACTION $^{12}C(d,\alpha_2)^{10}B(1.74, T = 1)$. Richards, H. T.; Smith, H. V. Jr. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 27: No. 25, 1735-7(20 Dec 1971).

The conclusion that a simple compound-nucleus interpretation fails for this reaction is questioned. (auth)

10787 TRANSITION RATE FOR GROUND STATE TO GROUND STATE IN THE CAPTURE OF NEGATIVE MUONS BY ^{12}C. Mukhopadhyay, Nimai C.; Macfarlane, Malcolm H. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Rev. Lett.; 27: No. 26, 1823-6(27 Dec 1971).

Analysis of ^{12}C ground-state μ^- capture leading to the ground state of ^{12}B reveals that (1) the induced tensor contribution is negligible, the induced pseudoscalar contribution marginal (<5% of the capture rate), and the weak-magnetism contribution sizable (~20%); and (2) the Gamow–Teller operator $\vec{\sigma}$ is the only nuclear multipole (~99%) effective in the process. A more accurate measurement of the transition rate may yield a useful independent determination of the weak-magnetism form factor. (auth)

10788 MANY-BODY GREEN'S FUNCTION APPROACH TO NUCLEAR REACTIONS. Clovis, George A. Jr. Athens, Ohio; Ohio Univ. (1971). 122p. University Microfilms Order No. 71-22,957.

Thesis.

The contribution of the two particle-one hole states to the total cross section for elastic neutron scattering on ^{12}C in the energy region below the first inelastic threshold was investigated. In particular, the focus is on the states which arise when a particle initially in the target ground state is excited by an interaction with the incident projectile, to a bound single-particle energy state above the ground state energy level of the target, and the incident projectile drops into another single-particle bound state, creating an intermediate configuration which has all the particles of the system in bound states, but which has a total energy greater than zero. These intermediate states are resonance states for the reaction when they are coupled to the initial configuration by the residual interaction. The Lippman–Schwinger equations were written in the integral representation, and the expression for the S-matrix then contained a matrix element which was related to the single-particle quantum Green's function. The generalized single-particle Green's function was then expanded in a perturbation series in terms of the residual interaction and the non-interacting Green's functions. The terms in the perturbation expansion were associated with Feynman diagrams, and the contribution of the two particle-one hole states was associated with one particular diagram and corresponding term in the second order. All diagrams through the second order were evaluated, and the contributions of these diagrams were also summed to all orders in the residual interaction. A square-well potential is used for the evaluation of the non-interacting Green's functions, where the parameters of the well are chosen to fit the single-particle levels representing a ^{13}C system. The residual interaction is a spatial delta function with a spin–spin interaction. The results of the calculations show that the two particle-one hole states make a significant contribution to the total cross section, however, in order to represent the experimental data, doorway states formed from linear combinations of the two particle-one hole states must be used. It is found that the principal contribution to the doorway states which resonate in the region of interest in carbon arises from the configuration, $[(1p_{\frac{3}{2}})^{-1}, (1p_{\frac{1}{2}}), (2s_{\frac{1}{2}})]$. The results also show that the contributions of the terms associated with the Hartree–Fock corrections to the shell-model potential are not small, as assumed by many authors, and that in the region of the single-particle resonance, the contribution of the Hartree–Fock term yields large S-matrix elements, and hence a large contribution to the total cross section. This result also indicates the need for further study of the Hartree–Fock terms and the generation of a Hartree–Fock potential and its associated wave functions as a basis for further study using this model. (Diss. Abstr. Int., B)

10789 ANALYSIS OF PROTON INELASTIC SCATTERING VIA ANALOGUE STATES BY CONFIGURATION-MIXING SHELL-MODEL CALCULATIONS AND R-MATRIX METHODS. Dalton, Bill Jack. Tallahassee; Florida State Univ. (1971). 158p. University Microfilms Order No. 71-24,602.

Thesis.

The theoretical research work described represents an attempt at describing the $^{89}Y(p,p')^{89}Y^*$ inelastic scattering via analog resonances. The model used assumes that the resonance which occur in this reaction are the isobaric spin analogs of the bound excited states of the nucleus ^{90}Y. A shell model with configuration mixing calculation is made for the nucleus ^{90}Y. The few parameters in the model are adjusted to fit the known energy levels in this nucleus. In order to describe the resonance reaction, a many-level R-matrix theory is used. The reduced widths occurring in the R-matrix formulation are defined in terms of the neutron single particle wave functions, and calculated configuration-mixing amplitudes for the nucleus ^{90}Y. Specification of the reduced widths in this way is the means by which the physical assumption that the resonance states are the analogs of the ^{90}Y bound states, is imposed. The elastic scattering involving the non-analog (T < channels) is described by the optical model. The background-scattering cross section for the inelastic scattering is described by the Hauser–Feshbach approximation method. The calculated excitation functions are compared to the measured ohm. There is some agreement between the calculated and experimental excitation function. The agreement was good enough for a few resonances to make plausible J^π assignments possible. However, several experimental resonances did not show up strongly in the calculated results. The explanation for this was the limited configuration bases used to describe the excited structure of ^{90}Y. However, certain other expected properties of the analog resonances and background scattering did result. One feature was the "spreading width" effect that the T < states had upon the resonance widths. Another was the energy dependent property of the background scattering. In general, the results of these resonance reaction calculations serve to illustrate that many channel resonance calculations can be carried out by using present day high-speed computers. (Diss. Abstr. Int., B)

10790 ZERO-DEGREE DIFFERENTIAL CROSS SECTIONS FOR NUCLEAR REACTIONS INDUCED BY ^6Li, ^7Li ON ^6Li, ^7Li, ^9Be FROM 4 TO 14 MeV. Wyborny, Harlan Wayne. Iowa City, Iowa; Univ. of Iowa (1971). 273p. University Microfilms Order No. 71-22,110.

Thesis.

Yield curves of protons, deuterons, tritons, and alpha particles are presented for 90 reaction channels of the ^6Li, ^7Li on ^6Li, ^7Li, ^9Be reactions. Although a few yield curves were measured at 40 and 175°, most of the measurements were taken at 0° from 4 to 14 MeV. Zero-degree data for the $^7Li(^7Li,\alpha_1)\ ^{10}Be^*$ (3.366 MeV state) reaction are presented from 2.1 to 21.0 MeV. A diversity in shapes and magnitudes of cross section was observed over the energy range studied. Yet a regular pattern emerged in several (^6Li, d), (^6Li, α), (^7Li, t), and (^7Li, α) channels; i.e., broad peaks with widths of the order of an MeV were observed to occur in several of these reactions at 0°. The width and frequency of the peaks were seen to vary with the sizes of the projectile and target masses. (auth)

10791 PROTON–GAMMA ANGULAR CORRELATION STUDIES OF ^{12}C, ^{58}Ni, and ^{54}Fe. Tesmer, Joseph Ransdell. Seattle; Univ. of Washington (1971). 172p. University Microfilms Order No. 71-24,086.

Thesis.

In-plane proton-gamma angular correlations for the first excited 2^+ states of ^{12}C, ^{58}Ni and ^{54}Fe have been measured at incident proton energies of 20 MeV for ^{12}C and ^{58}Ni, and 19.6 MeV for ^{54}Fe. The z-axis (spin-flip) correlation for ^{54}Fe was also measured at 19.6 MeV incident energy. The in-plane data gives five independent measurements of combinations of the amplitudes for exciting the five substates of the 2^+ state; the z-axis correlation gives another. The z-axis and in-plane correlations have been combined to give the substate populations as well as the substate cross sections. (The z-axis data for ^{12}C and ^{58}Ni have been determined in other experiments.) The spin-flip dependent parameters for ^{12}C show large deviations from those of either ^{58}Ni or ^{54}Fe and indicate the presence of spin-dependent forces not found in either ^{58}Ni or ^{54}Fe. The collective model DWBA predictions for ^{58}Ni and ^{54}Fe are in good agreement with the data when the full-Thomas form of the spin-dependent perturbation potential is used. The predictions for the ^{54}Fe data are further improved when the strength of the spin-dependent perturbation potential is increased such that $\beta_{so} = 2\beta_2$. (Diss. Abstr. Int., B)

10792 ANGULAR CORRELATION FOR THE REACTION $^9Be(^3He,\alpha)^8Be(2.9,\ 16.6-16.9)(\alpha)^4He$. Haddad, Dauod Imtanis. Washington, D. C.; Georgetown Univ. (1971). 101p. University Microfilms Order No. 71-23,412.

Thesis.

The $^9Be(^3He,\alpha)\ ^8Be(2.9,\ 16.6-16.9)$ reaction has been studied at bombarding energies of 1.5 and 2 MeV ^3He beam to find the angular correlation between the first emitted α-particle and one from the subsequent decay of $^8Be(2.9)$ and $^8Be(16.6-16.9)$ states. A fast-slow coincidence technique was used to accomplish that. Two surface barrier detectors, in a coplanar geometry, were employed in the coincidence circuitry with a 60 nsec resolving time. The reaction was found to be sequential through the g.s., 2.9, 11.4, 16.6, and 16.9 MeV states of ^8Be. Also, to find the contribution due to the 16.6 MeV state in the correlation data, an experiment was done to separate the 16.6 MeV and 16.9 MeV states of ^8Be. (Diss. Abstr. Int., B)

10793 LIGHT-NUCLEUS REACTIONS WITH DEFINITE ISOSPIN LEADING TO CORRELATED PROTON–NEUTRON FINAL STATES. Braithwaite, Wilfred John. Seattle; Univ. of Washington (1971). 102p. University Microfilms Order No. 71-24,020.

Thesis.

The reactions $^6Li(d,pn)$ and $^{12}C(\alpha,pn)$ were used to isospin decompose the strong proton–neutron resonance which occurs at low relative energies. This decomposition is possible since the initial state in each reaction involves only T = 0 particles. Therefore, for those T = 0 states of the residual nucleus, the corresponding proton–neutron system must also be T = 0, and for those T = 1 excited states of the residual nucleus, the corresponding proton–neutron system must also be T = 1. Using 21-MeV deuterons, the $^6Li(d,pn)$ reaction was studied by detecting protons in coincidence with neutrons and using 42-MeV alpha particles, the $^{12}C(\alpha,pn)$ reaction was studied by detecting recoiling ^{14}N nuclei in coincidence with protons. For each reaction, the energy and direction of both detected particles were determined, and measurements were made at several pairs of detector-angle values which included the kinematical region corresponding to a relative proton–neutron energy of zero. Strong peaking was observed only in the T = 1 spectra with both peak positions and widths in good agreement with calculations that assume the proton and neutron are held together by a final state interaction until outside the influence of the residual nucleus where the proton–neutron system subsequently decays. (Diss. Abstr. Int., B)

10794 ANGULAR DISTRIBUTION FROM THE REACTION $^{14}N(n,p)^{14}C$ AT 14 MeV. Coudurier, J.; Merchez, F.; Perrin, C. (Institut des Sciences Nucleaires, Grenoble, France). Lett. Nuovo Cim.; 2: No. 22, 1117-22(27 Nov 1971). (In French).

The reactions $^{14}N(p,p')^{14}N^*$ (2.31 MeV), $^{14}N(n,n')^{14}N^*$ (2.31 MeV), $^{14}N(p,n)^{14}O$, and $^{14}N(n,p)^{14}C$ correspond to the transition ($\Delta T = 1$, $1^+ \rightarrow 0^+$) of the ^{14}N ground state to each of the terms of the isospin triplet (T = 1, $J = 0^+$). According to the hypothesis of charge independence, they ought to have similar angular distributions for the same incident energy. In order to complete the appropriate measurements, the differential cross section for the last reaction was determined at 14 MeV and compared with the results already obtained for the other reactions and with a DWBA calculation. The peaks from charge-1 products were clearly resolved. The charge independence of nuclear forces in this reaction was experimentally confirmed. The DWBA analysis was done with microscopic interactions of the Majorana, Serber, and Wigner types. Use of a radial cutoff enhances the l = 0 contribution and results in an angular distribution that is close to the one obtained experimentally. (R.W.R.)

10795 SPIN-PARITY COMBINATIONS IN ^{18}O. Ollerhead, R. W. (Univ. of Guelph, Ont.). Allen, G. F. R.; Baxter, A. M.; Kuehner, J. A. Can. J. Phys.; 49: No. 20, 2589-98(15 Oct 1971).

Detection of inelastically scattered alpha particles near 180° from the reaction $^{18}O(\alpha,\alpha')^{18}O$ was used to identify natural parity levels in ^{18}O. Energy spectra were recorded for 13 incident energies from 20.0 to 23.4 MeV. Levels at 4.45, 5.09, and 5.25 MeV were identified as having natural parity, confirming earlier assignments of 1^-, 3^-, and 2^+, respectively. Levels at 5.37 and 5.52 MeV were identified as having unnatural parity leading to definite assignments of 3^+ and 2^-, respectively. The spin and parity of the 6.18 MeV level was restricted to 1^- or 2^+. Other levels at higher excitation energies were assigned natural parity, and the implications with regard to the identification of a negative parity band in ^{18}O are discussed. (auth) (Canada)

10796 EFFECT OF CHOICE OF NUCLEAR COUPLING SCHEME ON ELECTRO-DISINTEGRATION CROSS SECTIONS OF NUCLEI. Tartakovskii, V. K.; Petrov, V. K. (Inst. of

Theoretical Physics, Kiev. Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1198-1200(Jul 1971). (In Russian).

The electro-disintegration cross section is calculated for a number of light nuclei by using the shell model for both the l-s coupling scheme and the intermediate coupling scheme. The choice of coupling scheme for the nucleus has a noticeable influence on the value of electro-disintegration cross section. (tr-auth)

10797 STRUCTURE OF ^{12}C IN A CLUSTER MODEL WITH VARYING HINGE ANGLE. De Takacsy, N. (McGill Univ., Montreal). Nucl. Phys.; A178: No. 2, 469-78(1972).

The low-lying states of ^{12}C are studied in the cluster model by the method of Brink. Along with angular momentum projection, a limited Hill–Wheeler integral is carried out over a mode which has been called the hinge mode. Possible candidates are found for most of the observed states below 15 MeV and reasonable electromagnetic properties are obtained. (auth)

10798 FINITE-RANGE DWBA ANALYSIS OF (p,α) REACTIONS ON ^{9}Be AND ^{11}B. Devries, R. M.; Perrenoud, Jean-Luc; Slaus, I.; Sunier, J. W. (Univ. of California, Los Angeles). Nucl. Phys.; A178: No. 2, 424-36(1972).

The ground-state angular distributions of the reactions $^{9}Be(p,\alpha)$ ^{6}Li and $^{11}B(p,\alpha)^{8}Be$ are analyzed by means of the DWBA theory. One-step direct mechanisms only are considered, but for both reactions the inclusion of the heavy-particle pick-up is found to be essential. DWBA fits to the data are obtained (a) in the zero-range approximation, (b) in the "fixed-range" approximation and (c) by an exact finite-range calculation. Only the latter method yields both an acceptable fit and reasonable values for the spectroscopic factors. (auth)

10799 MEASUREMENT OF THE (p,α) REACTIONS ON ^{9}Be AND ^{11}B AT 45 MeV. Devries, R. M. (Univ. of California, Los Angeles); Sunier, J. W.; Perrenoud, Jean-Luc; (and others). Nucl. Phys.; A178: No. 2, 417-23(1972).

The angular distributions of the $^{9}Be(p,\alpha)^{6}Li$ reaction (first three states in ^{6}Li) and of the $^{11}B(p,\alpha)^{8}Be$ reaction (first two states in ^{8}Be) have been measured, at an incident proton energy of 45.0 MeV. The angular range covered goes from 20° to 160° in the c.m.s. and all cross sections are measured to a relative accuracy of 10% or better through most of this angular range. The angular distributions show the characteristic features of a direct-reaction process, but are also found to rise at backward angles. This is taken as a strong indication of a sizeable contribution of ^{5}He, respectively ^{7}Li, pick-up processes to the reaction mechanism. (auth)

10800 POLARIZATION OF ^{3}He PARTICLES ELASTICALLY SCATTERED FROM ^{9}Be, ^{12}C, AND ^{16}O. McEver, W. S. (Univ. of North Carolina, Chapel Hill); Clegg, T. B.; Joyce, J. M.; Ludwig, E. J.; Walter, R. L. Nucl. Phys.; A178: No. 2, 529-44(1972).

The polarization of ^{3}He particles scattered from ^{9}Be, ^{12}C and ^{16}O has been measured at 18 MeV (and 20 MeV for ^{12}C) over an angular range $\theta_{c.m.} = 20°$ to 60°. Cross-section angular distributions out to 170° have also been obtained. The polarization distributions for the three nuclei appear similar and compare reasonably well with optical-model calculations. A spin-orbit well depth greater than 3 MeV is required in the calculations to predict polarizations having the magnitudes of the measured values. Comparisons are made between the data and predictions which use optical-model parameter families related by the discrete and continuous ambiguities. (auth)

10801 (^{3}He,^{6}Li) REACTION ON SEVERAL NUCLEI IN THE REGION A = 10 TO 27. Oh, I. K.; Zaidins, C. S.; Zafiratos, C. D.; Hayakawa, S. I. (Univ. of Colorado, Boulder). Nucl. Phys.; A178: No. 2, 497-512(1972).

Angular distributions for the (^{3}He,^{6}Li) reaction were measured on the targets ^{12}C, ^{16}O, ^{19}F, ^{23}Na and ^{27}Al at a ^{3}He bombarding energy of 40.7 MeV, on ^{10}B, ^{12}C, ^{16}O and ^{19}F at 30.0 MeV and on ^{19}F at 22.4 MeV. The reaction was described within the framework of the zero-range DWBA theory, and triton reduced widths for the target nuclei were extracted. These experimental widths are compared with the theoretical triton reduced widths predicted by j-j coupling. (auth)

10802 STUDY OF ^{16}O BY THE REACTION $^{14}N(^{3}He,p)^{16}O$. Weibezahn, R.; Freiesleben, H.; Puehlhofer, F.; Bock, R. (Univ., Marburg, Ger.). Nucl. Phys.; A176: No. 3, 645-56 (1971).

The structure of the states of ^{16}O has been studied by means of the (^{3}He,p) reaction on ^{14}N. Angular distributions were measured between $\theta_{lab} = 5°$ and 60° at 18 MeV incident energy. The data were analyzed using DWBA and the shell-model wave functions of Zuker, Buck and McGrory. The transitions to the negative-parity 1p–1h states at $E_x = 6.13$, 7.12, 8.87 and 10.95 MeV are described very well. The 4p–4h structure of the positive-parity states at 6.05, 6.92 and 10.35 MeV is confirmed by their low cross sections. The 2^+ state at 9.85 MeV and the positive-parity states between 11.08 and 13.66 MeV are found to contain only a small part of the 2p–2h strength and it is suggested to identify these states with Arima's 4p–4h states with an excited ^{12}C core. The 2p–2h states seem to lie mainly above 14 MeV excitation energy. (auth)

10803 $^{9}Be(p,d)^{8}Be$ REACTION. Schoonover, J. L.; Li, T. Y.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys.; A176: No. 3, 567-76(1971).

The $^{9}Be(p,d)^{8}Be$ reaction at 46 and 100 MeV have been analyzed using the DWBA theory with a local-energy approximation. The deuteron optical potentials were obtained by fitting the angular distribution of the ground state transition. Reasonably good fits to the experimental data have been achieved. Spectroscopic factors were extracted from experiment using both the pure isospin wave functions and mixed isospin wave functions for the states in the 16 to 20 MeV region in ^{8}Be, and the results were compared with various shell-model predictions. It has been found that the agreement between theory and experiment was significantly better with the isospin-mixed wave functions than without isospin mixing. (auth)

10804 NEUTRON POLARIZATION PRODUCED IN $^{9}Be(^{3}He,n)$ REACTIONS FOR ^{3}He ENERGIES FROM 2.1 TO 3.9 MeV. Thomason, R. S.; Schaller, L. A.; Spalek, G.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). Nucl. Phys.; A176: No. 3, 535-44(1971).

Angular distributions of the neutrons polarization were measured for the n_0, n_1 and unresolved ($n_2 + n_3$) groups from the $^{9}Be(^{3}He,n)$ reaction for ^{3}He energies from 2.1 to 3.9 MeV. Helium was used as a polarization analyzer and a spin precession solenoid was used to simulate interchange of the "side" detectors. The shapes of the measured distributions show very gradual changes with energy. The maximum of the absolute values of the measured polarizations is less than 0.40. DWBA calculations were compared to 3.9 MeV cross section and polarization data for the $^{9}Be(^{3}He,n_0)$ reaction. Fits to 6 MeV ^{3}He–^{9}Be elastic scattering data were made to obtain optical-model parameter sets; other sets tried were obtained from published reports. Fair agreement with cross-section data was obtained but no satisfactory representation of the polarization data could be achieved, even with some further parameter variations. (auth)

10805 UNITARY MODEL OPERATOR APPROACH TO STRUCTURE IN THE 2s–1d SHELL. Nisley, Richard Arthur. Corvallis, Oregon; Oregon State Univ. (1971). 196p. University Microfilms Order No. 71-22,149.

Thesis.

Effective two-body interactions were obtained from realistic nucleon-nucleon potentials and applications made in calculations of ground state properties of even-even N = Z light nuclei. The admixture of high momentum states into the nuclear wavefunction caused by the strong, short-range repulsion of the two-nucleon force was taken into account by making a unitary substitution of correlated basis functions. The admixture of high momentum components into the nuclear wavefunction caused by the tensor force was handled by renormalizing the effective interaction to include second order effects. Effective interactions were developed for three phenomenological potentials with different core structures. The Bressel potential with a finite soft core was investigated briefly and found inadequate for use in structure calculations. The hard core Yale potential was used in studying ^{16}O in detail. And the Reid potential with a Yukawa-type soft core was used extensively in all the nuclei considered. The effective interactions for each realistic potential was investigated for dependence on the $^{3}S_1$ healing distance. Structure calculations included determination of ground state binding energies, radii, energy levels for the single particle states and deformations for the nuclei ^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, and ^{40}Ca. It was found that the binding was strongly dependent on the choice of the $^{3}S_1$ healing distance for both the Yale and Reid effective two-body interactions. By varying this single parameter, quantitative agreement for the binding with the experimental values could be achieved. The deformations found were somewhat smaller than empirically expected but were qualitatively correct. (Diss. Abstr. In., B)

10806 POSSIBLE RESOLUTION OF THE NITROGEN NONELASTIC NEUTRON CROSS-SECTION DISCREPANCY BELOW 9 MeV. Perey, F. G.; Kinnery, W. E. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 46: No. 3, 428-31(Dec 1971).

New measurements of differential elastic scattering cross sections of neutrons from nitrogen at six energies between 6.0 and 8.5 MeV yield nonelastic cross sections, which are in essential agreement with the sum of the measured nonelastic partial cross sections. The new data give results systematically lower than those obtained from previous measurements; the discrepancy in

the nonelastic cross sections of nitrogen below 9 MeV is thus removed. (auth)

10807 Li-INDUCED NUCLEON-TRANSFER REACTIONS BETWEEN 1p-SHELL NUCLEI: ISOSPIN AND FRACTIONAL-PARENTAGE STUDIES. Groeneveld, K. O.; Richter, A.; Strohbusch, U.; Zeidman, B. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 27: No. 26, 1806-10(27 Dec 1971).

Angular distributions for the one-nucleon-transfer reactions $^{14}N(^6Li,^7Li)^{13}N$ and $^{14}N(^6Li,^7Be)^{13}C$ were investigated at E(^{6}Li) = 32 MeV, and were compared with finite-range distorted wave calculations and theoretical spectroscopic factors. These one-nucleon-transfer reactions induced by complex nuclei are described by the calculations just as well as those induced by light projectiles. A detailed study of the relative cross sections of the isobaric-spin analog transitions shows deviations from isospin symmetry that are due to Coulomb effects. (auth)

10808 ^{6}Li(p,pd)^{4}He REACTION AT 100 MeV. Mackenzie, I. A. (McGill Univ., Montreal); Mark, S. K.; Li, Tseh Y. Nucl. Phys.; A178: No. 1, 225-40(1971).

An angular correlation experiment of the ^{6}Li(p,pd)^{4}He reaction at 100 MeV was performed using a symmetric and coplanar geometry and covering an angular range from 45.5 to 57°. In addition to the conventional $\Delta E-E$ telescope systems for the detection of both protons and deuterons, a 14° analyzing magnet was employed to select deuterons of a given momentum range. The results for the ground-state transition are consistent with those obtained at other incident energies. The angular distribution for the transition to the 20-MeV excited state of the recoiling α particle was also obtained, and the overall magnitude of the differential cross section is at least an order of magnitude smaller than that of the ground-state transition. The plane-wave impulse approximation (PWIA) was used to analyze the experimental results. A form factor was generated using the Saxon–Woods potential as the d–α inter-cluster potential. Satisfactory agreement between theory and experiment was obtained. A value of 0.45 ± 0.08 was extracted for the deuteron clustering probability on ^{6}Li. The exchange and the optical distortion effects were also discussed. (auth)

10809 d + ^{11}B → 3α + n FOUR-BODY BREAK-UP AND STATES IN ^{9}Be. Rendic, D.; Gabitzsch, N. D.; Valkovic, V.; Von Witsch, W.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys.; A178: No. 1, 49-59(1971).

The four-body break-up d + ^{11}B → 3α + n reaction was studied by simultaneous detection of $\alpha-\alpha$ and α–n coincidences at two bombarding energies, 10.425 and 12.0 MeV, in order to obtain information about the decay properties of the excited states in ^{9}Be. Measured spectra reveal the importance of sequential decay mechanisms in the reaction. The decay structure of low-lying levels in ^{9}Be is discussed. (auth)

10810 HYPERFINE INTERACTION STUDIES OF LIGHT NUCLEI IN HIGHLY IONIZED ATOMS RECOILING IN VACUUM. Berant, Z.; Goldberg, M. B.; Goldring, G.; (and others) (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A178: No. 1, 155-71(1971).

The hyperfine interaction in highly ionized atoms recoiling in vacuum was studied using perturbed angular correlations following nuclear reactions. Nuclei in the A = 12 to 24 mass range were investigated. The lifetimes of the nuclear states varied from 10^{-14} to 10^{-7} sec. The interaction was found to be static over the measured range of recoil velocities. For short nuclear lifetimes the interaction is due mainly to the unpaired 1s electron. With increasing lifetime, 2s and higher electronic configurations were found to play a prominent role. (auth)

10811 COMMENTS ON THE EXISTENCE OF BROAD RESONANCES IN ^{3}He. Bunker, S. N.; Jain, Mahavir; Tivin, P. J.; Van Oers, W. T. H. (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A178: No. 1, 83-7(1971).

Recently, experimental evidence has been presented for the existence of broad T = ½ resonances in the three-nucleon systems. As a continuation of earlier studies, the ^{6}Li(p,^{3}He) and ^{6}Li(p,α) reactions were investigated using 45.0-MeV incident protons. ^{3}He and α-particle spectra were measured at extreme forward angles using a $\Delta E-E-$VETO detector telescope in conjunction with an analog particle identifier. Excitation energies up to 30 MeV in ^{3}He could be examined. The spectra do not show any structure that can be related to the resonances observed previously; however, the spectra exhibit evidence for quasi-free scattering of protons from the α-cluster in ^{6}Li. (auth)

10812 GIANT-DIPOLE RESONANCE AND RADIATIVE PION CAPTURE IN ^{12}C. Skupsky, S. (Argonne National Lab., Ill. Univ. of Chicago). Nucl. Phys.; A178: No. 1, 289-306(1971).

Radiative pion capture is calculated for transitions to the odd-parity states of ^{12}B. The results agree with the experiment of Bistirlich et al. [Phys. Rev. Lett., 25: 689(1970)]. The nuclear wave functions were constructed by coupling an sd nucleon to low-energy states of the Cohen–Kurath model for ^{11}C. These wave functions were tested on muon capture and photoabsorption and were found to give results in remarkable agreement with experiment. (auth)

10813 ^{15}N(d,τ)^{14}C REACTION AND HIGH-LYING T = 1 STATES IN MASS-$_{14}$ NUCLEI: A DETERMINATION OF $1p_{\frac{1}{2}}^2$ AND $1p_{\frac{1}{2}}$ $1p_{\frac{3}{2}}$ DIAGONAL MATRIX ELEMENTS. Kaschl, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Mairle, G.; Mackh, H.; Hartwig, D.; Schwinn, U. Nucl. Phys.; A178: No. 1, 275-88(1971).

Energy spectra up to E_x = 20 MeV and angular distributions of ^{3}He particles from the ^{15}N(d,^{3}He)^{14}C reaction were measured at an incident energy of 52 MeV and were analyzed by the DWBA. Five strong l = 1 transitions to 1p proton hole states occur up to E_x = 11.29 MeV, which is 3 MeV above the particle emission threshold. The absence of direct l = 0 and l = 2 transitions demonstrates that ^{15}N is a good shell-model nucleus with respect to protons. The isobaric analog 1p hole states in ^{14}C and ^{14}N are identified by a comparison with T = 1 states excited in the ^{15}N(p,d) reaction. This implies the following assignments for ^{14}C levels: $J^\pi = 2^+$ for the 8.32-MeV level; $J^\pi = 1^+$ for a new level at 11.29 ± 0.04 MeV with a width of 150 ± 50 keV; $J^\pi = (0, 1, 2)^+$ for one of the 10.433- and 10.453-MeV levels. This state corresponds to the formerly unknown T = 1, T_z = 0 isobaric analog at 12.52 MeV in ^{14}N. The $J^\pi = 0^+$ and 1^+, T = 1 states of mass 14 are rather pure 1p hole states, while the $(2^+, 1)$ states are strongly mixed with (s,d)^2 configurations. The complete $1p^{-2}$ spectrum was observed. The six diagonal matrix elements of the $1p_{\frac{1}{2}}^{-2}$ and the $1p_{\frac{1}{2}}^{-1}$ $1p_{\frac{3}{2}}^{-1}$ interaction are determined and compared to theoretical results. The eight multipole coefficients $\alpha^{\kappa\tau}(j_1j_2)$ were calculated by the use of the energy weighted sum rules. The $1p_{\frac{1}{2}}^{-1}$ $1p_{\frac{3}{2}}^{-1}$ spectrum is nearly identical to one produced by a δ force without exchange terms. (auth)

10814 COMPARISON OF HARTREE–FOCK AND PEREY–BUCK NON-LOCAL POTENTIALS FOR LOW-ENERGY SCATTERING. MacKellar, A. D.; (Univ. of Kentucky, Lexington); Schenter, R. E. Nucl. Phys.; A178: No. 1, 249-56(1971).

The nonlocal Perey–Buck optical-model potential is studied by the equivalent local potential method for low-energy s-wave neutron scattering from ^{16}O and for the bound s-state, ^{16}O + neutron system. A comparison is made of the local equivalent Perey–Buck potential with a local potential derived from low-energy scattering with a Hartree–Fock potential, and the results are quite similar. Different forms of equivalent local potentials lead to differences in the calculated "Perey effect" near the origin and near wave-function nodes. (auth)

10815 REACTION ^{15}N(γ,p)^{14}C AT GIANT RESONANCE ENERGIES. Denisov, V. P.; Kul'chitskii, L. A.; Chubukov, I. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 5, 889-97(Nov 1971). (In Russian).

Proton spectra (E_p = 3 to18 MeV) were measured from the reaction ^{15}N(γ,p)^{14}C at 14 values of the bremsstrahlung maximal energy within $E_{\gamma\,max}$ = 19.6 to 38.3 MeV. It is established that the final ^{14}C nucleus is mainly produced in the ground and two excited states with the energy ~7 and 11 MeV. The cross section curves of (γ,p) reaction with the ^{14}C nucleus production in these states are obtained. It is found that the main contribution into the (γ,p) reaction cross section is given by transition to the level of ~7 MeV of the ^{14}C nucleus. The total integral cross section of the reaction ^{15}N(γ,p)^{14}C accounting for transitions to all the levels of the ^{14}C final nucleus comprises 73 ± 10 MeV-mb up to E_γ = 30.5 MeV. The comparison of theoretical and experimental data on the ^{15}N and ^{16}O photodisintegration shows that the results of the particle–hole calculation of proton channel of the giant resonance states decay are in better agreement with the experimental results in case of the nonmagic ^{15}N nucleus as compared to the neighboring double magic ^{16}O nucleus which possesses an essentially poorer set of one-particle transitions than ^{15}N. (auth)

10816 ABSORPTION OF STOPPED π^- MESONS IN NUCLEI ^{12}C, ^{19}F, AND ^{35}Cl. Goncharov, N. V.; Derebchinskii, A. I.; Konovalov, O. G.; Tonapetyan, S. G.; Khvorostyan, V. M. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 5, 922-6 (Nov 1971). (In Russian).

Capture of stopped π^- mesons by nuclei present in a mixture of freon-12 and freon-13 (50% CF_2Cl_2 + 50% CF_3Cl) was investigated. 13,800 stopping events in the sensitive volume of the 34-cm freon bubble chamber were studied. It is established that 34.4% of the capture events result in 0-prong stars, 58% in 1-prong stars, 7.1% in 2-prong stars, and 0.5% in 3-prong stars.

Energy spectra of the secondary particles, as well as the distribution of the stars according to the angles between the prongs, are measured. Analysis of the experimental data indicates a dominance of the two-nucleon mechanism of the nuclear capture of stopped π^- mesons. (auth)

10817 ELECTRO- AND PHOTOPRODUCTION OF CHARGED PIONS ON ^{11}B AND ^{27}Al. Noga, V. I.; Ranyuk, Yu. N.; Sorokin, P. V.; Tkachenko, V. A. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 5, 904-8(Nov 1971). (In Russian).

The cross sections of reaction $^{11}B(\gamma,\pi^-)^{11}C$ and $^{27}Al(\gamma,\pi^+)^{27}Mg$ were measured by the induced activity method at the γ-quanta energy from the pion production threshold up to 1200 MeV. In the energy region 150 to 270 MeV the ratio of the pion photo- and electroproduction is found to be constant and equals to 23 ± 7. (auth)

10818 DEUTERON ANGULAR DISTRIBUTIONS IN REACTIONS (γ,d) ON NUCLEI AT THE BREMSSTRAHLUNG MAXIMAL ENERGIES OF 620 AND 1140 MeV. Antuf'ev, Yu. P.; Agranovich, V. L.; Ganenko, V. B.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 5, 898-903(Nov 1971). (In Russian).

Deuteron angular distributions were studied in the angle interval 40 to 140° for deuteron energies of 90 and 160 MeV. The measurements have been performed for ^7Li, ^9Be, ^{12}C at the maximal energy E_0 = 620 MeV and for ^{12}C, ^{27}Al, ^{59}Ni, ^{181}Ta at E_0 = 1140 MeV. The results are analyzed using the models of the pion photoproduction on two-nucleon associations. The best agreement of the experimental data is observed for calculations according to the Butler–Pearson theory. (auth)

10819 DEUTERON STRIPPING AT 1.69 GeV/c. II. NEUTRON DISTRIBUTIONS. Dutton, L. M. C.; Jafar, J. D.; Van Der Raay, H. B.; (and others) (Univ. of Birmingham, Eng.). Nucl. Phys.; A178: No. 2, 488-96(1972).

The angular distributions of neutrons emitted in the forward direction when 1.69 GeV/c deuterons interact with various complex nuclei were measured. It is shown that these distributions are well fitted by compounding the incident nucleon momentum with its internal momentum in the deuteron assuming a Hulthén-type wave function. The observed distributions agree well with previously obtained proton distributions. (auth)

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Refer also to abstracts 9305, 9831, 10747, 10749, 10771, 10774, 10778, 10791, 10801, 10805, 10810, 10816–10819, 10824, 10885, 10897, 10899, 10923, 10943–10946, 10948, 10952, and 10953.

10820 (BNL–400(3rd Ed.)(Vol.2)) ANGULAR DISTRIBUTIONS IN NEUTRON-INDUCED REACTIONS. VOLUME II. Z = 21 TO 94. Garber, Donald I.; Stroemberg, Lars G.; Goldberg, Murrey D.; Cullen, Dermott E.; May, Victoria M. (Brookhaven National Lab., Upton, N. Y.). Jun 1970. 686p. (EANDC(US)–138(U)(3rd Ed.)-(Vol.2)). Dep. NTIS.

A compilation of experimental data on angular distributions of neutron scattering and fast neutron reactions on Z = 21 to 94 nuclei is presented in graphical form. Fission reactions and slow neutron scattering are excluded. (J.W.R.)

10821 (CEA-N-1476) USE OF THE CONTINUOUS SPECTRUM OF NEUTRONS PRODUCED IN A LINEAR ACCELERATOR FOR MEASURING GAMMA RAY PRODUCTION CROSS SECTIONS. Bertin, A.; Duigou, M.; Lucas, G. (Commissariat a l'Energie Atomique, Villeneuve-Saint-Georges (France)). 22 Aug 1971. 86p. (In French). Dep. NTIS (U. S. Sales Only).

The gamma ray spectra produced in the interaction of 1 to 10 MeV neutrons with aluminum, iron and bismuth are presented for a 90 degree angle. The neutrons are produced by an 18-MeV electron linear accelerator which delivers 3.5 nanosec. pulses. The gamma spectrum is recorded for each neutron energy interval (determined by time of flight methods). On-line two-parameter acquisition is performed by a CII 10020 computer. The production cross sections for the gamma lines present in the recoil spectra are evaluated. (France)

10822 (JINR-P1-6051) ENERGY PROPERTIES OF NEUTRONS FROM THE REACTION OF ABSORPTION OF NEGATIVE MUONS BY OXYGEN, SULFUR, CALCIUM, AND LEAD NUCLEI. Voitkovska, I.; Evseev, V. S.; Kozlovski, T.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

Energy spectra of neutrons from μ capture by O, S, Ca, and Pb were measured in the energy range 1.5 to 13 MeV. In the O, S, and Ca spectra anomalies were observed as separate lines and wide bands. This fact proves the hypothesis about the dominating role (in nuclear μ capture) of the transitions with the excitation of the quasi-bound states of the intermediate nucleus that are isotopic analogs of the states of the giant dipole resonance of the target nucleus. (auth)

10823 (JINR-P7-6093) COMPOUND NUCLEUS REACTION WITH ACCELERATED Xe IONS. Flerov, G. N.; Karamyan, S. A.; Popenko, G. S.; Popeko, A. G.; Shelaev, I. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

A nuclear reaction induced by accelerated Xe ions $^{24}Mg(^{132}Xe, 3-5n)^{153-151}Dy$ has been observed. The reaction products are identified by the gamma transition energy and half-lives. (auth)

10824 (KFK-1447) INVESTIGATION OF THE SYSTEMATICS OF EXCITATION FUNCTIONS AND THE DETERMINATION OF EFFECTIVE CROSS SECTIONS FOR DEUTERON REACTIONS ON ^{75}As. Roehm, Hermann F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Aug 1971. 78p. (In German). Dep. NTIS (U. S. Sales Only).

A systematic treatment enabling the estimation of unknown excitation functions of the type (p,xn), d,xn) and (α,xn) is given. A parameter was derived to describe the variation of the maximum cross-section values (σ_{max}) for these reactions in terms of various nuclear properties. The small scatter of experimental data for σ_{max} from the smooth curves, which approximated their systematic dependencies for the different reactions, showed that σ_{max} for unknown excitation functions may be predicted with relatively high accuracy. The following excitation functions for deuteron reactions with ^{75}As were measured in the energy range from 0 to 52 MeV: (d,2n), (d,4n), (d,5n), (d,p), (d,p2n), (d,p3n), and (d,2p). The experimental results were compared to calculations based on the statistical model. Furthermore, it was possible to extend the systematics in the case of the (d,4n) and (d,5n) reactions. (auth)

10825 (KFKI-71-52) M1 TRANSITION FROM g_9 ANALOGUE TO ANTI-ANALOGUE STATE IN ^{59}Cu, ^{61}Cu, ^{63}Cu, ^{65}Ga, AND ^{67}Ga NUCLEI. Szentpetery, I.; Szuecs, Judit (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Sep 1971. 8p. Dep. NTIS (U. S. Sales Only).

g_9 analog resonances were found in the $^{58,60,62}Ni(p,\gamma)^{59,61,63}Cu$ and $^{64,66}Zn(p,\gamma)^{65,67}Ga$ reactions, with strong M1 transitions to the corresponding anti-analog states. (auth)

10826 (LUNP-7011) SOME PHOTONUCLEAR REACTIONS IN ^{89}Y. Sternby, Jan (Lund Univ. (Sweden). Inst. of Physics). Sep 1970. 28p. (In Swedish). Dep. NTIS (U. S. Sales Only).

The yields of the reactions (γ,n), (γ,2n) and (γ,3n) in Y-89 were measured by activation analysis from 100 MeV to 800 MeV. For the (γ,2n) and (γ,3n) reactions, the isomeric ratios were also measured. The reactions show an increase of yields above the meson threshold. It is found that all neutrons in the highest filled level are available for (n,γ) reaction. The meson effect is most obvious in the (γ,3n) reaction where a cross section has been determined. The isomeric results for (γ,2n) and (γ,3n) depend only slightly on the energy. Corrections for decay during irradiation are made. Calculations of yields for the different reactions were done by comparison with the reaction $^{12}C(\gamma,n)^{11}C$. (KK) (Sweden)

10827 (LUNP-7110) A REVIEW OF INTERMEDIATE ENERGY PHOTOFISSION. Forkman, Bengt; Schroeder, Bent (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics. Lund Univ. (Sweden). Dept. of Physics). Sep 1971. 49p. Dep. NTIS (U. S. Sales Only).

A review is given of the photofission process in the energy region between 100 and 1000 MeV both from the theoretical and experimental point of view. It gives cross sections for elements in the mass region from iron to uranium. Figures are also given for the energy, mass and angular distribution of the fission fragments (JK) (Sweden)

10828 (LUSY-7004) EXPERIMENTAL CROSS SECTIONS FOR PHOTOPROTON EMISSION FROM NUCLEI IRRADIATED WITH 400-MeV BREMSSTRAHLUNG. 3. ANGULAR DISTRIBUTIONS FROM Cu, Ag, AND Au. Dougan, P.; Kivikas, T.; Lugner, K.; Ramsay, V.; Stiefler, W. (Lund Univ. (Sweden). Dept. of Physics). Sep 1970. 17p. Dep. NTIS (U. S. Sales Only).

Tables of experimental cross sections for photoproton emission from targets of natural Cu, Ag and Au irradiated with 400-MeV bremsstrahlung are presented. The range of proton energies covered is between 80 and 250 MeV and the angular range is approximately between 40 and 110 degrees. (auth) (Sweden)

10829 (LUSY-7006) EXPERIMENTAL CROSS SECTIONS FOR PHOTOPROTON EMISSION FROM NUCLEI IRRADIATED

WITH 400-MeV BREMSSTRAHLUNG. 4. ANGULAR DISTRIBUTIONS FROM O AND Ca. Dougan, P. (Lund Univ. (Sweden). Dept. of Physics). Sep 1970. 17p. Dep. NTIS (U. S. Sales Only).

Using bremsstrahlung of 400 MeV maximum energy, values of experimental cross sections for photoproton emission from targets of calcium and oxygen (water) were obtained. The data cover approximately the proton energy range between 80 and 280 MeV and the (laboratory) angular range between 14 and 100 degrees. (auth) (Sweden)

10830 (LYCEN-7132) STUDY OF THE EXCITED STATES OF ^{21}Na. Lambert, M.; Midy, P.; Drain, D.; Amiel, M.; Beaumevielle, H.; Dauchy, A.; Meynadier, C. (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1971. 52p. (In French). Dep. NTIS (U. S. Sales Only).

The 4.15, 4.293, 4.47, 4.98 and 5.03 MeV energy levels of ^{21}Na were studied using proton elastic and inelastic scattering and radiative capture by ^{20}Ne. The properties of the excited states below $E_x < 6$ MeV were compared with the corresponding states of ^{21}Ne and with the predictions of the Nilsson model. (France)

10831 (ORNL-4706, pp 1-31) NUCLEAR CHEMISTRY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

Some previously unreported data on ^{49}Ca decay, ^{49}Sc decay, ^{104}Rh decay, ^{104}Pd energy levels, ^{72}Ge energy levels, ^{72}As decay, ^{158}Gd energy levels, and ^{178}Hf energy levels are presented. (J.W.R.)

10832 (ORNL-TM-3584) Ca(n,xγ) REACTIONS FOR 4.85 ≤ E_n ≤ 8.05 MeV. Dickens, J. K. (Oak Ridge National Lab., Tenn.) 4 Oct 1971. 25p. Dep. NTIS.

Gamma-ray spectra were obtained for reactions involving neutron interactions with a sample of natural calcium. Gamma rays were observed which are associated with the reactions ^{40}Ca(n,n′γ) ^{40}Ca, ^{40}Ca(n,pγ)^{40}K, ^{40}Ca(n,αγ)^{37}Ar, and ^{42,44}Ca(n,n′γ)^{42,44}Ca. Incident neutron energies were E_n = 4.85, 5.4, 6.45, 7.0, 7.5, and 8.05 MeV, and the scattering angle was $\theta_\gamma = 125°$. The gamma rays were detected using a 45 cm^3 coaxial Ge(Li) detector placed at 100 cm from the sample; time-of-flight was used with the gamma-ray detector to discriminate against pulses due to neutrons and background gamma radiation. The sample was 20 g of natural calcium metal in the form of a right circular cylinder. The incident neutron beam was produced by bombarding a deuterium-filled gas cell with the pulsed deuteron beam of appropriate energy from the ORNL 6-MV Van de Graaff. The resulting neutron beam was monitored using a scintillation counter; a time-of-flight spectrum from this detector was recorded simultaneously with the gamma-ray data. These data were studied to obtain absolute cross sections for production of gamma rays from Ca for the incident neutron energies quoted above. More than 50 gamma rays were correlated with transitions among the residual nuclei; these assigned gamma rays have >90% of the total gamma production cross section for $E_n \leq 6.45$ MeV. All unplaced gamma rays have small cross sections and are most likely associated with transitions in ^{40}K. The cross sections were compared, where possible, with previously measured values and with results of the most recent evaluation for calcium with generally good agreement. Several important differences with previous data are discussed. (auth)

10833 EFFECTIVE PROTON-NEUTRON INTERACTION AND SPECTROSCOPY OF NUCLEI WITH N = 29. Horie, Hisashi; Ogawa, Kengo (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 439-61(Aug 1971).

The nuclei with N = 29 and Z = 20 ~ 28 are described by a shell model, assuming $(1f_{\frac{7}{2}})^{Z-20}$ configuration for protons and $(2p_{\frac{3}{2}}, 2p_{\frac{1}{2}}, 1f_{\frac{5}{2}})^1$ for one neutron outside the ^{48}Ca core. Effective two-body matrix elements between the $1f_{\frac{7}{2}}$-proton and $(2p_{\frac{3}{2}}, 2p_{\frac{1}{2}}, 1f_{\frac{5}{2}})$-neutron are determined by a least-square fitting to the observed level energies of the N = 29 isotones. These best-fit matrix elements reproduce the observed properties of the low-lying levels of these nuclei and also the experimental spectroscopic factors for the single-neutron transfer reactions. The observed M1-moments are adequately reproduced by using the resulting wave function and an effective g-factor for the neutron. (auth)

10834 γ DEEXCITATION OF ^{41}Ca LEVELS. Cohen, S.; Vergnes, M.; Rotbard, G.; Ronsin, G.; Kalifa, J. (Paris Univ., Orsay, France). J. Phys. (Paris); 32: No. 7, 491-7(Jul 1971). (In French).

The γ branching ratios were measured for ^{41}Ca levels at 3.200, 3.369, 3.400, 3.495, 3.527, 3.614, 3.676, 3.730, 3.845, 3.945, and 3.976 MeV by coincidence between protons and γ rays emitted in the ^{40}Ca(d,pγ)^{41}Ca reaction. Analysis of these data allowed tentative assignments for spins and parities to be made: $\frac{9}{2}$ ± (3.2 MeV), $\frac{11}{2}$ + (3.369 MeV), $\frac{3}{2}$ + (3.495 MeV), $\frac{1}{2}$ ± or $\frac{3}{2}$ + (3.527 MeV), $\frac{3}{2}$ − (3.614 MeV), I ≥ = $\frac{5}{2}$ (3.676 MeV), $\frac{5}{2}$ + (3.73 MeV), $\frac{3}{2}$ − or $\frac{5}{2}$ ± (3.976 MeV). The method is discussed and compared to more sophisticated calculations. (France)

10835 PHOTODISINTEGRATION OF ^{40}Ca. Shintomi, Takakazu; Yamaguchi, Chiri; Masuda, Masayoshi (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 1: No. 5, 1297-1303(Nov 1971).

Energy and angular distributions of the photoprotons from the ^{40}Ca(γ,p)^{39}K reaction have been measured using the bremsstrahlung beams with the end point energies of 25.5, 23.0, 20.5 and 18.0 MeV from a 31 MeV betatron. The dipole strengths are concentrated in the giant resonance region and are divided into seven peaks at 18.1, 18.7, 19.2, 19.9, 20.4, 20.9 and 21.5 MeV, rather strongly at 18.7, 19.2, 19.9 and 20.4 MeV. No significant peaks are observed above 22.5 MeV, which indicates that the absorptions in this energy region mainly lead the residual nucleus to the excited states and hardly to the ground. The asymmetric angular distributions around 90° observed in both sides of the giant resonance region suggest the existence of the absorption of M1 or E2. Collective correlations must be added to the shell model in order to explain the experimental results. (auth)

10836 PROPERTIES OF EXCITED STATES IN ^{48}Sc. Robertson, B. C.; Van Heerden, I. J.; McDonald, W. J. (Univ. of Alberta, Edmonton). Nucl. Phys.; A176: No. 1, 193-204(1971).

The properties of excited states in ^{48}Sc were studied using the ^{48}Ca(p,nγ)^{48}Sc reaction. The decay scheme of ^{48}Sc up to 3.16 MeV was determined from γ-ray excitation functions for incident proton energies between 2.6 and 3.9 MeV. Level spins and mixing ratios were assigned by comparing the measured γ-ray angular distributions with the predictions of the statistical compound-nuclear model. (auth)

10837 ^{29}Si(p,d)^{28}Si AND ^{30}Si(p,t)^{28}Si REACTIONS AND THE MIXING OF 1p HOLE AND 2p PARTICLE CONFIGURATIONS IN ^{28}Si. Wagner, Gerhard J. (Princeton Univ., N. J.). Nucl. Phys.; A176: No. 1, 47-64(1971).

Levels in ^{28}Si with excitation energies up to 12 MeV have been investigated with the ^{29}Si(p,d)^{28}Si and ^{30}Si(p,t)^{28}Si reactions at an incident energy of 35 MeV. Angular momenta and spectroscopic factors have been obtained from a DWBA analysis of the angular distributions. Spin and parity assignments of 2^- for the 9.76 MeV level and $(1,2)^-$ for the 9.93 MeV level of ^{28}Si have been established. The usefulness of the ^{30}Si(p,t)^{28}Si reaction as a spectroscopic tool appears to be limited since states with unnatural parity were excited with similar cross sections as most natural parity states. The emphasis lies on a discussion of the negative parity states. Considerable l = 1 spectroscopic strength was found at energies close to the expected position of 1p hole states. Arguments are brought forward in favor of a 1p assignment to the l = 1 transfer. A strong mixing of 1p hole and 2p particle configurations is concluded for the negative parity states of ^{28}Si. (auth)

10838 HIGH-ENERGY PHOTONUCLEAR REACTIONS IN VANADIUM AND IRON. Kumbartzki, G.; Kim, U. (Univ., Bonn). Nucl. Phys.; A176: No. 1, 23-32(1971).

Yields of photonuclear reactions in vanadium and iron were measured by the activation method at 1.5 GeV bremsstrahlung energy and analyzed with an empirical spallation formula given by Rudstam. Yields of light nuclei (20 < A < 30) were found to be much larger than expected from the systematics of spallation products with mass number A > 30. The energy dependence of the yields and the recoil energy of these nuclei investigated in a catcher-foil experiment deviate considerably from the general behavior of spallation products. The yields of the photopion reactions ^{51}V(γ,π$^+$)^{51}Ti and ^{51}V(γ,π$^-$ 2n)^{49}Cr were measured in the energy range between 1.0 and 2.1 GeV. (auth)

10839 SPECTROSCOPIC AND REACTION MECHANISM INFORMATION FROM (d,pγ) ANGULAR CORRELATIONS AT 0°. Critchley, J. B.; Calvert, J. M.; Joy, T. (Univ. of Manchester, Eng.). Nucl. Phys.; A176: No. 1, 129-41(1971).

Use of a magnetic analyzer enabled detection of protons at 0° from (d,p) reactions so that p-γ correlations could be studied. The ^{28}Si(d,p)^{29}Si(4.93 MeV) → ^{29}Si(g.s.) reaction was studied at a bombarding energy of 5 MeV (the yield being low at lower energies) and the ^{9}Be(d,p)^{10}Be(3.37 MeV) → ^{10}Be(g.s.) reaction at energies of 4 and 5 MeV. Both reactions are known to be well described by l = 1 neutron capture. The measured correlation in the ^{28}Si case is analyzed in terms of a general formalism with a limited number of substates populated or in terms of spin-dependent DWBA. It is found that at least 97% of the reaction amplitude can be ascribed to spin-independent stripping. In the ^{9}Be case, similar restrictions cannot be applied but with the assumption of spin-independent stripping a channel-spin ratio for (S = 1)/(S = 2) of 0.30 ± 0.06 is found. (auth)

10840 LEVELS OF ^{31}P FROM α-PARTICLE CAPTURE IN ^{27}Al. De Voigt, M. J. A.; Regenboog, D. A.; Grootenhuis, J.; Van Der Leun, C. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A176: No. 1, 97-109(1971).

Resonance energies, strengths and decay schemes have been determined for seventeen ^{27}Al(α,γ)^{31}P resonances in the range E_α = 2.3–3.3 MeV. New levels of ^{31}P are reported at E_x = 6503 ± 3, 6792 ± 3, 7117.7 ± 1.0, 7441.4 ± 1.0, and 8345.5 ± 1.5 keV. The reaction Q-value is found as 9665.1 ± 1.3 keV. Doppler-shift attenuation measurements lead to the mean lives τ_m = 130 ± 50, 300 ± 80, 90 ± 20, 90 ± 50, 35 ± 18, 220 ± 90, 120 ± 50, 17 ± 14, and 39 ± 10 fs for the ^{31}P levels at E_x = 3.30, 3.41, 4.63, 4.78, 6.45, 6.79, 6.83, 7.44, and 8.35 MeV, respectively, and to eight upper and one lower limits for the mean lives of other levels. These lifetimes and the combined evidence of the decay of the resonance levels and bound states limit the possible J^π values for many levels of ^{31}P. (auth)

10841 INVESTIGATION OF THE DECAY OF ^{56}Co BY $\gamma\gamma$ ANGULAR CORRELATION MEASUREMENTS. Agarwal, Y. K.; Hofmann, S.; Wien, K. (Technische Hochschule, Darmstadt, Ger.). Nucl. Phys.; A176: No. 1, 142-54(1971). (In German).

Directional correlation measurements have been made on several γ-cascades in ^{56}Fe. Spins of the levels at 4395, 4298, 4120, 4100, 4049, 3856, 3445, and 3123 keV were deduced. Multipole mixing ratios for the γ-transitions with energies 977, 1038, 1175, 1360, 1772, 1964, 2015, 2213, 2599, 3010, 3202, 3273, and 3548 keV were determined. The results are discussed in the framework of recent shell-model calculations and the vibrational model. (auth)

10842 (α,t) REACTION ON MEDIUM-WEIGHT ODD-MASS NUCLEI. II. ^{59}Co. Matoba, Masaru (Kyushu Univ., Fukuoka); Kumabe, Isao; Takasaki, Eiichi. Nucl. Phys.; A176: No. 1, 178-92(1971).

Angular distributions have been measured from 15 to 55°(lab) for the ^{59}Co(α,t)^{60}Ni reaction at 29.0 MeV and analyzed by the DWBA theory. Zero-range DWBA calculations gave better fits to the l_p = 3 and l_p = 1 transitions with the depths of the real parts of the α-particle and triton potentials equal to 204.0 and 142.0 MeV, respectively. The results gave information about 1p-1h states of the ^{60}Ni nucleus containing the particular ($1f_{\frac{7}{2}}^{-1}$-one particle) components. (auth)

10843 LOW-LYING LEVELS OF ^{24}Na. Buisman, A. S. Keverling; Smith, Ph. B.; Smulders, P. J. M.; Gruppelaar, H. (Univ., Groningen, Netherlands). Nucl. Phys.; A176: No. 1, 161-77(1971).

The ^{26}Mg(d,$\alpha\gamma$)^{24}Na reaction has been used to study levels in ^{24}Na. Combining evidence from angular correlations with lifetime limits and information from published (d,p) and (d,τ) results, restrictions on several J^π assignments are given. In addition the existence of two new levels (at 1344.4 ± 0.3 and 2905 ± 15 keV) has been confirmed, and firm assignments of J = 3 and $J^\pi = 3^+$, respectively have been made to these states. The decay scheme of all levels observed up to an excitation energy of 3.4 MeV is presented, as well as a summary of possible multipole mixing ratios. (auth)

10844 DOPPLER SHIFTS WITH GAS BACKINGS: MEAN LIVES IN ^{17}O, ^{25}Mg, AND ^{55}Fe. Donahue, D. J.; Hershberger, R. L. (Univ. of Arizona, Tucson). Phys. Rev., C; 4: No. 5, 1693-9(Nov 1971).

Measurements of Doppler shifts of γ rays from nuclei recoiling in gas are described. Mean lives of the 0.87-MeV state in ^{17}O, of the 0.58- and 0.97-MeV states in ^{25}Mg, and of the 0.41-, 0.93-, 1.32-, and 1.41-MeV states in ^{55}Fe produced by (d,p) reactions were obtained from these Doppler shifts. The effect on these mean lives of a variation in the deuteron current was investigated. Finally, the known mean lives of the 0.87-MeV state in ^{17}O and the 0.58-MeV state in ^{25}Mg were used, together with the measured Doppler shifts, to obtain information concerning the slowing down of ^{17}O and ^{25}Mg ions in krypton gas. (auth)

10845 SPECTROSCOPY OF SOME LOW-LYING STATES IN ^{69}Zn. Steiner, W. S.; Hausman, H. J.; Kent, J. J.; (and others) (Ohio State Univ., Columbus). Phys. Rev., C; 4: No. 5, 1684-93 (Nov 1971).

The analog resonances of some low-lying states of ^{69}Zn were investigated using the triple-angular-correlation geometry of Goldfarb and Seyler [Phys. Lett., B; 28B: 15(1968)] for the reaction ^{68}Zn(p,p$_i\gamma$)^{68}Zn* (1.08 MeV). Excitation functions for elastic and inelastic protons (0^+, ground state; 2^+, 1.08 MeV; 0^+, 1.66 MeV; 2^+, 1.88 MeV) were measured at 90, 120, 130, and 160°. The following spin and parity assignments are made for the states in ^{69}Zn: 0.835 MeV, $\frac{3}{2}^-$; 0.872 MeV, $\frac{5}{2}^+$; 1.634 MeV, $\frac{5}{2}^+$; 1.696 MeV, $\frac{1}{2}^+$; 2.262 MeV, $\frac{1}{2}^+$; 2.403 MeV, $\frac{5}{2}^+$; 2.554 MeV, $\frac{5}{2}^+$; and 2.669 MeV, $\frac{1}{2}^+$. (auth)

10846 CONVERSION COEFFICIENTS OF LOW-ENERGY GAMMA RADIATION FOLLOWING THE DECAY OF ^{81}Se AND ^{81m}Se. Nainan, T. D. (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., C; 4: No. 5, 1680-3(Nov 1971).

A Ge(Li) γ-ray spectrometer and a Si(Li) electron spectrometer were standardized for measurements of internal-conversion coefficients using γ transitions of well-known α_K and α_L values from standard sources. The internal-conversion coefficients of four γ transitions in ^{81}Br and one in ^{81}Se were measured. The results for the conversion coefficients are as follows: ^{81}Se, 103 keV: α_K = 7.1 ± 0.3, α_L = 1.6 ± 0.3; ^{81}Br, 178 keV: α_K < 0.05, α_L < 0.003; 260 keV: α_K = 0.038 ± 0.001, α_L = 0.005 ± 0.002; 276 keV: α_K = 0.009 ± 0.001, α_L = 0.002 ± 0.001; 290 keV: α_K 0.012 ± 0.001, α_L = 0.002 ± 0.001. The multipolarities are deduced to a fair degree of certainty. (auth)

10847 PHOTONEUTRON CROSS SECTIONS FOR ^{23}Na AND ^{25}Mg. Alvarez, R. A.; Berman, B. L.; Lasher, D. R.; Phillips, T. W.; Fultz, S. C. (Univ. of California, Livermore). Phys. Rev., C; 4: No. 5, 1673-9(Nov 1971).

Nearly monochromatic photons from positron annihilation in flight were used to measure photoneutron cross sections for ^{23}Na and ^{25}Mg in the giant-resonance region. The shape of the giant resonance of each of these nuclei is rather broad, with less striking intermediate structure than in most neighboring sd-shell nuclei. In ^{23}Na the total photoneutron cross section rises to approximately 10 mb at 17.5 MeV and remains essentially constant up to 25 MeV. In ^{25}Mg the total photoneutron cross section reaches a peak of 28 mb at 23.1 MeV and falls to approximately half that magnitude at the upper energy limit of the experiment (29 MeV). In both nuclei the (γ,2n) cross section appears to rise slowly above threshold but does not exceed 1 mb within the energy limits of the experiment. The integrated cross sections for ^{23}Na and ^{25}Mg are 119 and 249 MeV-mb, respectively; the bremsstrahlung-weighted integrated cross sections are 5.7 mb for ^{23}Na and 11.7 mb for ^{25}Mg. (auth)

10848 LIFETIME OF THE 90.65 keV STATE IN ^{49}V AND THE DECAY OF ^{49}Cr. Cheung, H. C.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys.; A176: No. 1, 219-24(1971).

The relative γ-ray intensity and β-decay branching ratio in the decay of ^{49}Cr have been re-measured with well calibrated high-resolution Ge(Li) detectors. The result differed notably from previously reported values. The half-life of the 90.65 keV state in ^{49}V has been measured to be $T_{\frac{1}{2}}$ = 0.43 ± 0.02 nsec and the result was compared with shell-model predictions. (auth)

10849 GAMMA-RAY TRANSITION IN A = 35 NUCLEI. Prosser, F. W. Jr. (Aerospace Research Labs., Wright-Patterson AFB, Ohio. Univ. of Kansas, Lawrence); Harris, Gale I. Phys. Rev., C; 4: No. 5, 1611-21(Nov 1971).

The mean lifetime of the 1.99-MeV $\frac{7}{2}^-$ level of ^{35}S was determined by a measurement of the delayed coincidence between protons and γ rays in the reaction ^{34}S(d,pγ)^{35}S at E_d = 4.48 MeV, with the result τ_m = 1.47 ± 0.07 nsec. The γ decay of the $\frac{7}{2}^-$, T = $\frac{3}{2}$ analog of this level at E_x = 7.55 MeV in ^{35}Cl was examined in detail with large-volume Ge(Li) detectors and Ge(Li)–NaI(Tl) coincidence techniques. The γ-ray spectra obtained at the analog state, which appears as a well-known resonance at E_p = 1211 keV in the reaction ^{34}S(p,γ)^{35}Cl, revealed the presence of several previously unknown transitions in addition to the known strong analog-to-antianalog M1 transition to the $\frac{7}{2}^-$, T = $\frac{1}{2}$ level at 3.16 MeV. Examples are a crossover M2 transition from the analog resonance to the $\frac{3}{2}^+$ ground state of ^{35}Cl with a strength of 3.0 ± 0.8 Weisskopf units, a mixed E1–M2 transition (δ = 0.44 ± 0.12) from the $\frac{7}{2}^-$ antianalog state to the $\frac{5}{2}^+$ level at 1.76 MeV, and a 160-keV transition between the antianalog state and the $\frac{5}{2}^+$ level at 3.00 MeV. Weak transitions, which can be interpreted as members of cascades through levels in the region E_x = 4.3 to 5.7 MeV, were also identified. It is shown that the M1, E2, M2, and E3 strengths of transitions connecting members of the system of parent, analog, antianalog, and ground states can be accurately reproduced by a simple model based upon an inert ^{32}S core with active nucleons in the $d_{\frac{3}{2}}$ and $f_{\frac{7}{2}}$ orbits, with bare-nucleon g factors for the magnetic transitions, and with reasonable effective charges for the electric transitions. The wave functions for the $\frac{7}{2}^-$ levels derived from this model are used to predict strengths of mirror transitions in ^{35}Ar and ^{35}K. (auth)

10850 FINE STRUCTURE OF ANALOG RESONANCES IN ^{51}V. Abbondanno, U.; Giacomich, R.; Lagonegro, M. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Lett. Nuovo Cim.; 2: No. 16, 839-45(16 Oct 1971).

Excitation functions were measured for (p,p), (p,p′), and (p,n) reactions on ^{50}Ti at E_p = 3580 to 3625 keV. The data were ana-

lyzed to obtain widths and spin-parity assignments for isobaric analog resonances in ^{51}V. (J.W.R.)

10851 STUDY OF THE γ RADIATION BETWEEN 0.1 AND 1.6 MeV ACCOMPANYING THE DISINTEGRATION OF ^{77}Ge. Ythier, Christian; Poncet, Maryse (Univ., Nice). Compt. Rend., Ser. B; 273: No. 11, 407-9(13 Sep 1971). (In French).

Studies on the disintegration of ^{77}Ge revealed the existence of more than 36 new γ transitions; the energies and relative intensities were measured. (France)

10852 MEAN RECOILS, ISOMERIC RATIOS, AND EXCITATION FUNCTIONS FOR REACTIONS INDUCED IN Rb BY α PARTICLES. Demeyer, A.; Chevarier, N.; Chevarier, A.; Tran Minh Duc (Univ., Lyon). J. Phys. (Paris); 32: No. 8, 583-93 (Aug 1971). (In French).

Excitation functions corresponding to reactions induced in ^{85}Rb by α particles were compared with those induced in ^{88}Sr by protons, in order to test the independence hypothesis on the decay of the ^{89}Y compound nucleus. It is from the mean free recoil path that the energy range in which such a comparison is valid can be determined. Analysis of the isomeric ratios led to information on the spin parameter. Furthermore isomeric ratio studies were used to study the spin parameter. The shifted Fermi gas model and the superconductor model were tested. (France)

10853 HALF-LIVES OF ^{84}Zr AND ^{85}Zr. Yu, Y.-W.; Caretto, A. A. Jr. (Carnegie-Mellon Univ., Pittsburgh). J. Inorg. Nucl. Chem.; 33: No. 10, 3223-5(Oct 1971).

The half-lives of ^{84}Zr and ^{85}Zr were determined by periodic chemical isolation and yield determination of the respective yttrium daughters from chemically purified zirconium isolated from zirconium targets irradiated with 400 MeV protons. The half-life of ^{84}Zr was found to be 5.0 ± 0.5 min, in serious disagreement with the value previously reported. The half-life of ^{85}Zr was found to be 6.0 ± 1.0 min in good agreement with the literature value. (auth)

10854 ELECTROMAGNETIC TRANSISTION IN ^{51}V AND ^{53}Mn. Goodman, Allan Stephen. Tucson, Ariz.; Univ. of Arizona (1971). 152p. University Microfilms Order No. 71-21,989.

Thesis.

The particle-gamma-ray coincidence version of the Doppler-shift attenuation method was used to obtain mean lives for states in ^{51}V and ^{53}Mn. In addition, the particle-gamma-ray method for angular correlations was used to measure multipole mixing ratios in ^{53}Mn. From the results the spin of the 2.277-MeV level in ^{53}Mn is determined to be $\frac{5}{2}$, the spin of the 2.691-MeV level in ^{53}Mn is either $\frac{9}{2}$ or $11/2$, and the parity of the 2.277-MeV level in ^{53}Mn is found to be negative. Branching ratios for all levels below 2.71 MeV in ^{53}Mn were also determined. Of these five branching ratios were determined from data at 90° only, and seven branching ratios were obtained from data at several angles. Finally, evidence is presented for the existence of a previously unknown state in ^{56}Mn. The level energy of this state is 2.56 MeV, and its spin and parity are probably $15/2^-$. Using the above results, the reduced transition probabilities for electromagnetic transitions among some of the low lying levels in ^{51}V and ^{53}Mn were obtained. These results were compared with the Weisskopf single-particle estimates, with the predictions of the pure $[1f_{\frac{7}{2}}^3]^J$ shell model, and with the predictions of the configuration-mixed shell model. (Diss. Abstr. Int., B)

10855 NUCLEAR STRUCTURE STUDIES WITH REALISTIC INTERACTIONS. Singh, Rughubansh Prasad. Buffalo; State Univ. of New York (1971). 127p. University Microfilms Order No. 71-22,600.

Thesis.

The low-lying levels of nuclei having three of four nucleons outside the ^{56}Ni core are investigated within the framework of the shell model. The Kuo and Brown effective interaction matrix elements, which are obtained from the Hamada–Johnston potential, are employed and a comparison with the observed energy levels of ^{59}Cu, ^{59}Ni, ^{60}Zn, and ^{60}Cu made. The spectroscopic factors for the reactions ^{58}Ni(^{3}He,d)^{59}Cu, ^{58}Ni(d,p)^{59}Ni, ^{59}Ni(^{3}He,d)^{60}Cu, and ^{59}Cu(^{3}He,d)^{60}Zn are calculated with the view to test the wavefunctions obtained in these calculations. The odd mass nickel isotopes ^{59}Ni, ^{61}Ni, ^{63}Ni, and ^{65}Ni are then described within the framework of the modified Tamm–Dancoff approximation. Though the Kuo and Brown matrix elements have been previously employed in some standard shell-model calculations, the present study tests their suitability for employment in complex nuclear structure calculations. These calculations have the obvious advantage over the conventional calculations of this type in that they do not have any adjustable parameters. (Diss. Abstr. Int., B)

10856 STATISTICAL MODEL CALCULATIONS OF ^{56}Fe NEUTRON CROSS SECTIONS. Bloom, S. D. (Univ. of California, Davis); Green, J. M.; Hubbard, H. W.; Moszkowski, S. A. Nucl. Sci. Eng.; 46: No. 2, 255-65(Nov 1971).

Calculations are presented of cross sections for the following five neutron-induced processes on ^{56}Fe: (n,γ), (n,n'), (n,p), (n,2n), and (n,np); neutron energies ranged from 10 keV to 18 MeV, depending on the process. The calculations were carried out using the ABACUS–NEARREX code modified by the addition of a subroutine that modeled statistically the final-state level distributions whenever experimental data were lacking. The statistical parameters for the level density formula used in this subroutine were obtained by normalizing to experimental level densities in ^{56}Fe and ^{56}Mn and to low-energy ($\lesssim$ 7 MeV) (n,n') and (n,p) cross sections. The parameters so derived are in good agreement with those derived from the nuclear shell model. In general, the agreement between the calculations and the experimental cross sections for the five processes enumerated is excellent. It appears clear that the compound statistical model is very good for predicting total reaction rates of this type. (auth)

10857 ENERGY DEPENDENCE OF PROTON INELASTIC SCATTERING FROM ^{40}Ca. Kuo, Thomas Yao-ting. East Lansing, Mich.; Michigan State Univ. (1970). 248p. University Microfilms Order No. 71-23,208.

Thesis.

Inelastic proton scattering from the nucleus ^{40}Ca has been performed at 25, 30, 35 and 40 MeV beam energies. The target used was 99.97% enriched in the ^{40}Ca isotope. Spectra were taken simultaneously by two surface barrier Ge(Li) detectors. The overall resolution (FWHM) was 30-35 keV. Angular distributions from 13 to 97° for elastic scattering and about 40 inelastic states were obtained. The L-transfer quantum numbers for most of the observed states have been obtained and compared with the results of other experiments. Some ambiguities existing in previous experiments were clarified. States with L-transfer larger than 5 were observed. The deformations δ_L were extracted from DWBA collective model analysis of the angular distributions. It was found that the deformations were more or less energy independent, but exceptions are expected. The reduced transition probabilities B(EL) scaled for the (p,p') experiment were obtained using Fermi equivalent uniform-density-distribution. Antisymmetrized distorted wave calculations were performed for some negative parity states using the Kallio-Kolltveit force and T. T. S. Kuo's R. P. A. wave functions. The particle-hole configurations of these states were investigated. It was found that the central force used in the ADW calculations is adequate in predicting the distributions of the normal parity states, but a tensor force may be essential to reproduce those of the unnatural parity states. (Diss. Abstr. Int., B)

10858 SINGLE PROTON TRANSFER REACTIONS ON N = 50 NUCLEI. Harrison, James Freeman. College Station, Tex.; Texas A and M Univ. (1971). 98p. University Microfilms Order No. 71-24,677.

Thesis.

Angular distributions have been measured for the ground, 1.836, 3.220, 3.488, and 3.634 MeV states of ^{88}Sr using the ^{89}Y(d,^{3}He)^{88}Sr reaction with bombarding energies of 30, 35.5, and 40 MeV. The observed J dependence for l = 1 transfers is adequately predicted by the DWA analysis as a function of incident energy. Angular distributions have been measured for the ground, 0.403, 0.846, and 1.578 MeV states of ^{87}Rb using the reaction ^{88}Sr(d,^{3}He)^{87}Rb with a bombarding energy of 35 MeV. The spins and parities of the states of ^{88}Sr and ^{87}Rb correspond to those previously reported except for the 1.578 MeV state of ^{87}Rb. It is tentatively identified as a $\frac{1}{2}^-$ state based on an l = 1 angular distribution and extracted spectroscopic factors. Angular distributions for the ground, 0.91, 1.49, and 1.74 MeV states of ^{89}Y have been measured using the ^{88}Sr(^{3}He,d)^{89}Y reaction with a bombarding energy of 33.4 MeV. Spectroscopic information from the ^{88}Sr(^{3}He,d)^{89}Y and ^{88}Sr(d,^{3}He)^{87}Rb reactions indicates that the ground state wave function is given by $\sqrt{0.7}\ (2p_{\frac{1}{2}})^{-2} + \sqrt{0.2}\ (2p_{\frac{3}{2}})^{-2} + \sqrt{0.1}\ (1f_{\frac{5}{2}})^{-2}$ which is in good agreement with a theoretical calculation. (Diss. Abstr. Int., B)

10859 SHELL MODEL CALCULATION OF ^{49}Ti. Baltz, Anthony John. Cleveland; Case Western Reserve Univ. (1971). 32p. University Microfilms Order No. 71-22,778.

Thesis.

A shell model calculation is performed for ^{49}Ti making use of the two body reaction matrix elements of Kuo and Brown. Two different truncations of the model space are tried in an attempt to fit the spectroscopic data. Spectroscopic factors for pickup reactions, ^{50}Ti(p,d)^{49}Ti and ^{50}V(t,α)^{49}Ti, and the stripping reactions, ^{48}Ti(d,p)^{49}Ti and ^{49}Ti(d,p)^{50}Ti, are calculated and compared with experiment. The log ft for the β transition ^{49}Sc → ^{49}Ti

is also calculated and compared with experiment. The results seem at least a qualitative improvement over a previous calculation of McCullen, Bayman, and Zamick. (Diss. Abstr. Int., B)

10860 MEASUREMENTS OF SEVERAL NUCLEAR LIFETIMES BY THE RESONANCE FLUORESCENCE METHOD. Imada, Hitoshi. College Station, Tex.; Texas A and M Univ. (1971). 103p. University Microfilms Order No. 71-24,681.
Thesis.

Measurements of the mean lifetimes of the 1014 keV level in ^{21}Al, the 991 keV level in ^{64}Zn, the 963 keV level in ^{152}Sm, the 961 keV and 670 keV levels in ^{63}Cu, and the 771 keV level in ^{65}Cu have been performed using the nuclear resonance fluorescence technique with Compton scattered gamma rays from a ^{60}Co source. Resonance scattering experiments yield the mean lifetimes of $(2.13 \pm 0.19) \times 10^{-12}$ sec for the 1014 keV level in ^{27}Al, $(3.11 \pm 0.22) \times 10^{-12}$ sec for the 991 keV level in ^{64}Zn, $(3.57 \pm 0.27) \times 10^{-14}$ sec for the 963 keV level in ^{152}Sm, $(1.30 \pm 0.19) \times 10^{-12}$ sec for the 961 keV level in ^{63}Cu, $(2.32 \pm 0.30) \times 10^{-13}$ sec for the 670 keV level in ^{63}Cu, and $(1.36 \pm 0.16) \times 10^{-13}$ sec for the 771 keV level in ^{65}Cu. These measurements are, in general, in good agreement with values in the literature. Mean lifetimes have been obtained with an accuracy of about ten percent. (Diss. Abstr. Int., B)

10861 QUASI-FREE ELECTRON SCATTERING ON ^{12}C AND ^{40}Ca. Bussiere, A.; Mougey, J.; Phan Xuan Ho; Priou, M.; Sick, I. (CEN de Saclay, Gif-sur-Yvette, France). Lett. Nuovo Cim.; 2: No. 22, 1149-53(27 Nov 1971).

The quasi-elastic scattering of electrons by ^{40}Ca and ^{12}C at 500 MeV is reported. Analysis of the missing-mass spectra obtained in the impulse approximation yields the binding energies of the various proton shells. Cross sections for the various shells are tabulated for initial proton momenta of 25 and 100 MeV/c; the errors are estimated to be 15%. (R.W.R.)

10862 ROTATIONAL PROPERTIES OF THE ^{25}Mg DOUBLET AT 2.7 MeV. Dias, M. G. F.; da Silva, M. F.; da Silva, C. M. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). J. Phys., A (London); 4: No. 6, 918-22(Nov 1971).

The reaction ^{27}Al(d,α)^{25}Mg was used to study the decay of the ^{25}Mg levels at 2.738 and 2.801 MeV. A simple rotational model calculation without band mixing did not account for the measured branching ratios. The discussion of the existing experimental data suggests that band mixing plays an important role in this case. (auth) (UK)

10863 DECAY OF 45 DAY ^{59}Fe. Oesterlund, K.; Jungner, H. (Helsinki Univ.). Commentat. Phys.-Math.; 41: No. 2, 123-30 (Jun 1971).

The gamma rays following the decay of 45-day ^{59}Fe were studied using the techniques of gamma ray Ge(Li) and scintillation spectrometry, including γ-γ angular correlation measurements. Gamma ray energy and intensity values found mainly agreed with earlier results. Spin values of $3/2^-$ and $1/2^-$ were arrived at for the 1292 keV and 1433 keV levels, respectively. (auth) (Finland)

10864 ELASTIC AND INELASTIC NEUTRON SCATTERING CROSS SECTIONS OF ^{54,56}Fe, ^{58,60}Ni, AND NATURAL CARBON. Lindow, James Thomas. Cleveland; Case Western Reserve Univ. (1970). 123p. University Microfilms Order No. 71-19,021.
Thesis.

Measurements of the differential scattering cross sections for elastically and inelastically scattered neutrons on ^{54,56}Fe, ^{58,60}Ni and ^{12}C were made using pulsed beam, time-of-flight techniques. Neutrons at 4.04 MeV, 5.06 MeV, and 5.60 MeV, obtained from the D(d,n)^{3}He reaction, were scattered from cylindrical samples of the isotopes. The absolute cross section scale was set using the well known H(n,n) cross section as a secondary standard. Samples of a hydrocarbon scintillator NE 102 were employed as hydrogen scatterers. Scintillation light from nuclei recoiling after neutron scattering was used in addition to time-of-flight information to better separate hydrogen and carbon scattering events. Corrections for all finite sample size effects were made using very complete Monte-Carlo programs. The local energy dependent potential of Rosen was used to calculate elastic differential cross sections for comparison with those measured. Very good agreement was obtained especially in the case of the nickel isotopes. Most of the measured inelastic angular distributions show a high degree of symmetry about 90° as was expected. The first excited, 2+ states of the iron and nickel isotopes show sufficient asymmetry, however, to indicate a significant direct interaction contributions. (Diss. Abstr. Int., B)

10865 LIFETIME MEASUREMENTS IN ^{42}Sc. Roberson, N. R.; Van Middelkoop, G. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A176: No. 3, 577-91(1971).

Levels of ^{42}Sc were populated with the ^{40}Ca(τ,p)^{42}Sc reaction at E_τ = 8.4 and 8.6 MeV. Gamma rays were measured in coincidence with protons. From Doppler-shift attenuation measurements mean lifetimes (or limits) have been obtained for 15 levels below E_x = 4 MeV. Also, for many states accurate (1-2 keV) excitation energies were obtained. The lifetimes have been compared with calculations based on the wave functions of Flowers and Skouras which have both spherical and deformed components. (auth)

10866 LIFETIME MEASUREMENTS ON LEVELS OF ^{52}Mn, ^{57}Co, AND ^{123}I. Cheung, H. C.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys.; A176: No. 3, 489-96(1971).

The half-lives of the following states have been measured by delayed coincidence techniques the 1^+ 548 keV state in ^{52}Mn; the $1/2^-$ 1504.7 keV state in ^{57}Co and the $1/2^+$ 148.9 keV state in ^{123}I. The result for ^{52}Mn is discussed in terms of the seniority selection rules and compared with the prediction of the shell-model calculation of McCullen et al. The experimental result for ^{57}Co is discussed in terms of single-particle and collective states, and the result for ^{123}I is compared with the prediction of the Kisslinger and Sorensen model. (auth)

10867 STUDY OF THE ^{31}P(^{3}He,p)^{33}S REACTION. Nann, H.; Hubert, B.; Bass, R. (Univ., Frankfurt am Main). Nucl. Phys.; A176: No. 3, 553-66(1971).

Angular distributions of four proton groups from the reaction ^{31}P(^{3}He,p)^{33}S have been measured at incident energies between 6 and 14 MeV. The 14 MeV data are compared with DWBA calculations based on two sets of shell-model wave functions. The influence of various parameters on the DWBA analysis and its sensitivity to small wave-function components are discussed. (auth)

10868 CALCULATED THERMAL (n,α) CROSS SECTION FOR ^{59}Ni. Kirouac, G. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 46: No. 3, 427-8(Dec 1971).

The (n,α) cross section of ^{59}Ni for thermal neutrons was calculated by the Hauser-Feshbach formalism to be ~30 b, which is in substantial agreement with the value of 11 b required to produce the helium concentration observed by Weitman et al., [Trans. Amer. Nucl. Soc., 13: 2(1970)] in samples of nickel irradiated by neutrons. (auth)

10869 SEARCH FOR 0^+ ANTIANALOG STRENGTH WITH EVEN-TARGET (^{3}He,p) REACTIONS. Hansen, Ole (Los Alamos Scientific Lab., N. Mex.); Nathan, O. Phys. Rev. Lett.; 27: No. 26, 1810-13(27 Dec 1971).

Results from even-target (^{3}He,p) reactions in the Ca-Fe region are surveyed. It is found that the 0^+ T_{lower} antianalog states are excited with much less strength than expected from isobaric-spin coupling rules. (auth)

10870 EXCITATION ENERGIES OF LEVELS IN ^{16}F, ^{20}Na, AND ^{24}Al. Moss, C. E.; Comiter, A. B. (Univ. of Colorado, Boulder). Nucl. Phys.; A178: No. 1, 241-8(1971).

Neutron time-of-flight spectra from the reactions ^{16}O(p,n)^{16}F, ^{20}Ne(p,n)^{20}Na, and ^{24}Mg(p,n)^{24}Al at E_p = 23 MeV were used to locate levels in ^{16}F, ^{20}Na, and ^{24}Al. The excitation energies are compared with previously reported values and with the predictions from Coulomb displacement calculations. (auth)

10871 NUCLEON-NUCLEUS SPIN-SPIN INTERACTION. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng. Univ. of Surrey, Guildford, Eng.). Nucl. Phys.; A178: No. 1, 17-29 (1971).

Values of the triple-scattering D parameter for proton-nucleus scattering at 20 and 50 MeV are analyzed using a spin-spin-dependent term in the nucleon-nucleus optical-model potential. The potential values obtained are found to be consistent with those from analyses of the scattering of polarized neutrons by aligned nuclei and in broad agreement with those derived from a microscopic description of the interaction potential. (auth)

10872 EXPERIMENTAL METHOD FOR STUDYING ATOMIC NUCLEI THROUGH PHOTONEUTRON REACTIONS INDUCED BY BREMSSTRAHLUNG. Baciu, G. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 7, 773-803(1971). (In Rumanian).

Experimental techniques used in the study of photonuclear reactions are reviewed; several block diagrams and circuit schematics are given. Experimental results obtained from (γ,n) and (γ,xn) reactions with light, intermediate, and heavy nuclei are reported. Excitation functions are given for the following reactions: ^{16}O(γ,n)^{15}O at 15.5 to 25 MeV; ^{19}F(γ,n)^{18}F at 11 to 24 MeV; (γ,xn) with natural Co, Cu, Ga, and Ni at 10 to 27 MeV; and ^{12}C(γ,n)^{11}C at 19 to 25 MeV. Information is

also presented on photoneutron reactions with ^{75}As and ^{181}Ta. (59 references) (R.W.R.)

10873 GAMMA RAYS FROM (p,nγ) REACTION ON ^{50}V, ^{54}Cr, ^{64}Ni, ^{67}Zn, AND ^{70}Zn. Mishchenko, V. M.; Popov, A. I.; Storizhko, V. E. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 711-16(May 1971). (In Russian).

Gamma-ray spectra from the (p,nγ) reaction on ^{50}V, ^{54}Cr, ^{64}Ni, ^{67}Zn, and ^{70}Zn were studied using a Ge(Li) spectrometer at incident beam energies $E_p \leq 3$ MeV. Gamma-ray energies and their relative intensities were determined. Decay schemes for the low-lying levels of ^{54}Mn, ^{64}Cu, and ^{67}Ga are proposed. (auth)

10874 STUDY OF γ-RADIATION FOLLOWING keV NEUTRON CAPTURE IN CALCIUM ISOTOPES. Chan, D. M. H. (Univ. of Melbourne, Parkville, Australia); Bird, J. R. Aust. J. Phys.; 24: No. 5, 671-85(Oct 1971).

Gamma-ray spectra from the capture of keV neutrons by ^{40}Ca, ^{42}Ca, and ^{44}Ca are analyzed, and evidence is obtained for 10 resonances between 10 and 100 keV as well as gamma-ray transitions to $1/2^-$, $3/2^-$, $5/2^-$, $7/2^-$, $1/2^+$, and $3/2^+$ final states. Gamma-ray intensities fluctuate from resonance to resonance, and the average values show no overall correlation with thermal capture or (d,p) results. The results are interpreted in terms of s-, p-, and d-wave resonances and E1 transitions to final states with complex configurations. (auth)

10875 DECAY AND LIFETIMES OF LEVELS IN ^{21}Ne. Bailey, D. C.; Carr, P. E.; Durell, J. L.; (and others) (Univ. of Liverpool). J. Phys., A (London); 4: No. 6, 908-17(Nov 1971).

Levels in ^{21}Ne were studied using the reaction ^{18}O(α,n)^{21}Ne. Lifetimes were obtained for the states at 350, 1745, 2866, 3662, 3883, 4432, 5772, and 6548 keV by the Doppler shift attenuation method. The lifetimes are generally a factor of two to four smaller than previous measurements. The major part of these differences may be accounted for by discrepancies between the Warburton and Blaugrund approaches to the stopping theory when heavy stoppers are used. The lifetimes are compared with Nilsson-model calculations and with predictions of the projected Hartree–Fock model. (auth) (UK)

10876 BETA DECAY OF ^{27}Si. Berenyi, D.; Hutcheon, D. A.; Start, D. F. H.; Weaver, J. J. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A178: No. 1, 76-82(1971).

The β^+ decay of the $5/2^+$ ground state of ^{27}Si(4.17 sec) to the ground and excited states of ^{27}Al was studied using a Ge(Li) detector, and the following positron branching ratios were obtained: ground state ($5/2^+$), 99.82 ± 0.05%; 1.013 MeV ($3/2^+$), <0.09%; 2.209 MeV ($1/2^+$), 0.18 ± 0.05%; and 2.732 MeV ($5/2^+$), <0.10%. The log-ft values deduced from these results are compared with the predictions of the shell model, the Nilsson model, and the excited-core model for the mass-27 system. (auth)

10877 BETA-DELAYED α-EMISSION FROM ^{24}Al AND ^{24m}Al. Torgerson, David F.; Oakey, Neil S.; Macfarlane, Ronald D. (Texas A and M Univ., College Station). Nucl. Phys.; A178: No. 1, 69-75(1971).

Alpha particles emitted from levels in ^{24}Mg following the β decay of ^{24}Al were measured. In addition to the α groups previously reported in the β decay of the 4^+ ground state of ^{24}Al, new groups were observed as a result of using special techniques to reduce the β background and to increase particle energy resolution. Alpha-particle groups associated with the β decay of the 1^+ isomeric state of ^{24}Al were observed for the first time. The α-particle transitions observed in this work are correlated with known energy levels. Log-ft values were calculated or estimated from the relative intensities of the delayed α-particle groups. (auth)

10878 E2–M1 MIXING RATIO FOR THE $2_2^+ \rightarrow 2_1^+$ TRANSITION IN ^{60,62}Ni. Van Patter, D. M.; Hoffman, E. J.; Becker, T.; Assimakopoulos, P. A. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A178: No. 2, 355-64(1972).

The E2/M1 mixing ratio for the $2_2^+ \rightarrow 2_1^+$ transition in ^{60,62}Ni has been measured using a reaction-independent method involving ratios of the coefficients of the same order of Legendre polynomial from singles angular distribution data (accuracy $\gtrapprox 1\%$) for the cascade and crossover γ-ray transitions. Values of $\delta = -0.68 \pm 0.22$ and -3.19 ± 0.11 were obtained for ^{60}Ni and ^{62}Ni, as well as branching ratios (crossovers/cascades) of 0.161 ± 0.008 and 1.242 ± 0.017 respectively. Weighted averages of available nuclear spectroscopic information yield values of 542 ± 65 (^{58}Ni), 315 ± 60 (^{60}Ni) and 25.7 ± 0.4 (^{62}Ni) for the ratio of the reduced E2 transition rates, $B(E2: 2_2^+ \rightarrow 2_1^+)/B(E2: 2_1^+ \rightarrow 0_1^+)$. The trend of these values is not well reproduced by any of the various shell-model calculations employing exact configuration mixing or quasiparticles. (auth)

10879 LEVEL OF ^{40}Ca AT 6.75 MeV. Sinex, C. H.; Cox, R. S.; Class, C. M. (Rice Univ., Houston, Tex.). Nucl. Phys.; A178: No. 2, 612-24(1972).

The 6.75-MeV level of ^{40}Ca was populated by means of proton inelastic scattering and the properties accessible to study through its γ-ray decay were determined. This level is found to decay only to the second excited state at 3.74 MeV. The energy of the transition is found to be E = 3013.7 ± 1.5 keV placing the level at an excitation energy of 6750.5 ± 1.5 keV. The mean lifetime of the level as measured by the method of Doppler-shift attenuation is determined to be $\tau_m = 185 \pm 65$ fs. On the basis of pγ double and pγγ triple angular correlation measurements, a spin J = 2 is assigned to the level and a value of $\delta = 0.84 \pm 0.16$ to the mixing ratio of the 3.01 MeV γ-ray. An M1 – E2 multipolarity for this transition is inferred from the combined lifetime and correlation results and thus the parity of the level is determined to be odd. Electromagnetic transition strengths computed from these data are $B(M1) = (0.66 \pm 0.26) \times 10^{-2}\ \mu_0^2$ and $B(E2) = 7.4 \pm 3.0\ e^2 \cdot fm^4$. (auth)

10880 INVESTIGATION OF THE REACTION ^{64}Ni(p,nγ)^{64}Cu. Mishchenko, V. M.; Popov, A. I.; Storizhko, V. E. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 5, 915-21(Nov 1971). (In Russian).

The excitation function, the γ-ray angular distributions, and the nγ correlations were measured for the reaction ^{64}Ni(p,nγ)^{64}Cu at $E_p \leq 3.1$ MeV. Analysis of the experimental data on the basis of the statistical model and the theory of angular correlations for aligned nuclei enables one to determine the characteristics of the levels with energies of 159, 278, 344, and 362 keV unambiguously. The result is 2^+, 2^+, 1^+, and 3^+, respectively. The mixture coefficients δ(E2/M1) are determined for the γ transitions with energies 159(0.036 ± 0.041), 185($\delta \leq 0$), 203(0.049 ± 0.012), 278(0.028 ± 0.030), and 344 keV (0.12 ± 0.11 or $\delta > 3$). It is shown that the angular distribution of γ rays near the threshold of the (p,nγ) reaction is identical to the nγ correlation measured by means of the Fergusson second method. (auth)

10881 γ-RAY SPECTRUM FROM REACTION ^{58}Fe(n,γ)^{59}Fe. Bogdanov, A. P.; Knat'ko, V. A.; Soroka, A. V.; Tadeush, V. N. (Inst. of Physics, Minsk). Yadern. Fiz.; 14: No. 5, 909-14 (Nov 1971). (In Russian).

The spectrum of γ rays emitted in the capture of thermal neutrons by ^{58}Fe was studied using a Ge(Li) spectrometer. Energies and intensities of the γ lines released are determined. On the basis of these data the scheme of γ transitions of the ^{59}Fe nucleus from the initial state in the (n,γ) reaction is proposed. There is a strong anticorrelation between reduced probabilities of γ transitions of the E1 type from initial state and reduced neutron widths of the final p levels. (auth)

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Refer also to abstracts 8878, 9305, 9435, 9444, 9688, 10384, 10747, 10749, 10778, 10818–10822, 10824, 10827, 10828, 10831, 10860, 10866, 11007, 11008, 11031, and 11046.

10882 (AE-429) NEUTRON ENERGY SPECTRA FROM NEUTRON INDUCED FISSION OF ^{235}U AT 0.95 MeV AND OF ^{238}U AND 1.35 AND 2.02 MeV. Almen, E.; Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 16p. Dep. NTIS (U. S. Sales Only).

Results from studies of the energy spectra of the neutrons emitted in the neutron induced fission of ^{235}U and ^{238}U are presented. The measurements were performed at an incident neutron energy of 0.95 MeV for ^{235}U and at energies of 1.35 and 2.02 MeV for ^{238}U using time-of-flight techniques. The time-of-flight spectra were only analyzed at energies higher than those of the incident neutrons and up to about 10 MeV. Corrections for neutron attenuation in the uranium samples were calculated using a Monte Carlo program. The corrected fission neutron spectra were fitted to Maxwellian temperature distributions. For ^{235}U a temperature of 1.27 ± 0.01 MeV gives the best fit to the experimental data and for ^{238}U the corresponding values are 1.29 ± 0.02 MeV at 2.02 MeV. (auth) (Sweden)

10883 (AWRE-O-55/71) EVALUATION OF $\bar{\nu}$ FOR ^{235}U. Mather, D. S.; Bampton, P. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug 1971. 23p. (EANDC-(UK)-132-AL). Dep. NTIS (U.S. Sales Only). UK 17p.

An evaluation was made of direct measurements of $\bar{\nu}$ for the neutron induced fission of ^{235}U using data available before Janu-

ary 1971, and evaluated values were entered into a new data file DFN-271. Below 1.75 MeV a nonlinear variation is evident, with a step-like structure between 0.2 and 1.4 MeV; a spline fitted curve is used to describe this region. For the energy range 1.75 to 15.0 MeV the evaluation is specified by a set of 4 straight lines. (auth)

10884 (CEA-N-1459) PROPERTIES OF LEVELS INDUCED BY RESONANCE NEUTRONS IN STABLE Nd ISOTOPES. Tellier, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 50p. (In French). Dep. NTIS (U. S. Sales Only).

High resolution measurements were carried out on separated isotopes of Nd using the 60 MeV Saclay linac as a pulsed neutron source. The resonance parameters were obtained by analyzing the shape of the curves using a single level Breit-Wigner analysis. The density functions for the s neutrons were subsequently deduced. The values obtained are compared with those predicted by the optical model. The experimental results established for most of the isotopes a large variation in S_0 with energy, this variation had not been observed previously. (France)

10885 (CEA-N-1466(1)) CROSS SECTIONS OF THE NUCLEAR REACTIONS INDUCED BY PROTONS, DEUTERONS, AND ALPHA PARTICLES. I. MONITOR REACTIONS. Tobailem, Jacques; de Lassus St-Genies, Charles-Henri; Leveque, Liliane (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 92p. (In French). Dep. NTIS (U. S. Sales Only).

The most frequently used monitor reactions are reviewed. When necessary, published experimental data have been corrected. Excitation functions are proposed for 9 reactions induced by protons, 3 by deuterons and 5 by alpha particles. (France)

10886 (DP-MS-70-109) IMPROVED DETERMINATION OF ^{236}Pu FORMATION DURING ^{238}Pu PRODUCTION. Paulson, C. K. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 13 May 1971. Contract AT(07-2)-1. 11p. (CONF-710606-16). Dep. NTIS.

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

Newly derived high energy (γ,n) and (n,2n) cross sections of ^{237}Np have been used successfully to calculate the ^{236}Pu/^{238}Pu ratios for a variety of ^{237}Np irradiations at Savannah River. ^{236}Pu comes from the β-decay of ^{236}Np which is formed as shown. Both the (γ,n) and (n,2n) reactions have a 6.8 MeV threshold. Only one-half of the ^{236}Np formed decays to ^{236}Pu. Theoretically determined $\sigma_{37}^{\gamma,n}$ and $\sigma_{37}^{n,2n}$ overestimate ^{236}Np production. A method of determining these cross sections from measured ^{236}Pu/^{238}Pu ratios of two SRP irradiations is discussed. The newly derived cross sections were verified by the excellent agreement between calculated and measured values of the ^{236}Pu/^{238}Pu ratio for widely differing irradiation environments. The ^{236}Pu/^{238}Pu ratio is one measure of the quality of the ^{238}Pu product, which also contains higher isotopes of plutonium. In typical operation at Savannah River, this ratio has been approximately 1.2 ppM. However, higher quality ^{238}Pu (0.3 ppM) has also been produced in the reflector of high flux charges. (auth)

10887 (FRNC-CONF-12) SYSTEMATIC RESULTS FOR THE ISOTOPES In, Cd, AND Ag. Rivier, J.; Moret, R. (Grenoble Univ. (France). Institut des Sciences Nucleaires). 1971. 16p. (In French). (CONF-710636-1). Dep. NTIS (U. S. Sales Only).

From Conference on intermediate nuclei; Orsay, France (30 Jun 1971).

A bibliographic list concerning the isotopes of In, Cd and Ag (radioactivity, nuclear reactions, elastic and inelastic scattering, and Coulombian excitation) is given. (France)

10888 (FRNC-TH-95) STUDY OF THE EXTERNAL PHOTOELECTRIC EFFECT AND ITS APPLICATIONS TO LOW ENERGY NUCLEAR SPECTROSCOPY. Oms, Jacques (Grenoble Univ. (France). Faculte des Sciences). 1971. 108p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The efficiency of the external conversion process was studied in view of applications of the external photoelectric effect to γ-ray spectrometry. Measurements made using a cylindrical geometry with a thin converting layer on low-energy standard γ cascades are valid up to at least 40 keV; the results are accurate to within 5 to 10 percent, such an accuracy being comparable with curved crystal measurements. Values obtained for the relative intensities of ^{153}Gd and ^{155}Eu standard cascades by using this method complete curved-crystal measurements. The effect of scattering on the angular distribution of the photoelectrons produced in the K shell of Pb by 279-keV photons was studied. The multiple scattering of electrons by thin films at medium angles was measured using a β spectrometer, and the effect of electron scattering in the source on the e-γ angular correlations was deduced. Measurements of the internal conversion coefficients by the IEC (internal external conversion) method using semiconductor detectors demonstrated that γ spectrometry measurements using the external photoelectric effect are valid. (France)

10889 (FRNC-TH-98) INTERPRETATION OF THE ENERGY LEVELS AND TRANSITION PROBABILITIES IN EVEN-EVEN NUCLEI IN TERMS OF NUCLEAR SHAPES. Johnson, Annie (Paris Univ. (France). Faculte des Sciences). 1971. 59p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Shapes of nuclei and their abilities to undergo deformations were studied. The validity of calculations based on effective or trial residual interactions was verified. The shapes of the nuclei were deduced from the energies and multipolar momenta of their low energy collective levels. The transition elements corresponding to platinum nuclei deficient in neutron (^{192}Pt, ^{190}Pt, ^{188}Pt, ^{186}Pt and ^{184}Pt) and neutron-rich strontium nuclei (^{90}Sr, ^{92}Sr, and ^{96}Sr) were studied in particular. The position of the energy levels of the even-even nuclei and their variation with mass were investigated. Nuclei far from the stability region were considered, necessitating the use of on-line techniques. (France)

10890 (FRNC-TH-107) EQUIPMENT FOR STUDYING HEAVY IONS: APPLICATION TO SOME PROBLEMS ASSOCIATED WITH MEDIUM ENERGY FISSION. Engelhardt, H. D. (Grenoble Univ. (France)). 1971. 196p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Equipment was developed for heavy-ion spectrometry and, in particular, for the study of the kinetic energy of fission fragments, using coincidence techniques, and the time spectra of the two fragments arising from the disintegration of an isomeric recoil nucleus. By using this equipment the kinetic energy spectra and the angular distributions of the fission fragments in the ^{209}Bi(p,f) reaction were measured for different excitation energies of the compound nucleus. The fission fragments from the recoil nuclei, the compound nuclei formed in the bombardment of U, Th, Bi and Au isotopes with 26- and 50-MeV α particles were detected, and an attempt was made to establish the existence of isomers. The Griffin model was used to analyze the experimental results, and the fission isomers were interpreted using the phenomenological theory of Strutinski. (235 references) (France)

10891 (JINR-P3-6026) INVESTIGATION OF THE ENERGY SPECTRA OF α-PARTICLES FROM THE ^{235}U TERNARY FISSION IN RESONANCES. Wilhelmi, I.; Popov, Yu. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The experimental data on the parameters of the energy spectra of α-particle from the ^{235}U ternary fission in separate resonances are presented. The spectra are approximated by the Gaussian curves. A systematic deviation of the high-energy spectrum parts is observed. The values of the average energies ($\bar{E}_\alpha$) and the total widths (ΔE) of the Gaussian curves are listed as well as the ratios of intensities of the high-energy parts, fitting not into the Gaussian distributions, to the total intensities of α-particles (N_H/N_C) is separate resonances and the ratios of ternary fission to the binary one (N_T/N_B). In the distribution ΔE and N_H/N_C there was observed the division of values into two groups, while values $\bar{E}_\alpha$ and N_T/N_B are not divided. (auth)

10892 (JINR-P6-6040) QUANTUM CHARACTERISTICS OF SOME LEVELS IN ^{135}La. Zhuk, V.; Krupa, E.; Morozov, B. A.; Muminov, T. M.; Fuya, Kh.; Khalikulov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Angular correlations in ^{135}La are measured for the following cascades: 567-206, 664-206, 605-265 and 571-300 keV. The analysis of the data obtained allows one to define the spin value for 206 keV level ($I^\pi = 5/2^+$), to determine the multipolarity of the 576 (M1 + 12% E2), 605 (M1 + 15% E2) transitions and to prove the spin value for 300 keV level ($I^\pi = 1/2^+$). (auth)

10893 (JINR-P6-6080) INVESTIGATION OF THE ANGULAR CORRELATIONS IN ^{151}Gd. Vavryshchuk, Ya.; Zhuk, V.; Krupa, E.; Kuznetsov, V. V.; Morosov, V. A.; Fula, H.; Khalikulov, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the nucleus ^{151}Gd and γ-γ angular correlations were measured for the following cascades: 287-108, 180-287, 192-287, 479-208, 444-287, 252-479, 252-587, 731-108, 615-180, and 180-108 keV. The spins of the excited states at 395.2(3/2), 575.3 (1/2), 587.5(3/2), and 839.3(3/2) keV and the multipolarities of the transitions of 108.1 (M1 + 80% E2), 180.2 (M1 + 4.5% E2), 192.0

(M1 + 4.5% E2), 443.8 (M1), 479.2 (M1 + 9% E2), 587.5 (E2 + 1% M3) and 731.7 (M1 + (24.5–95.5)% E2) keV were determined in analyzing the experimental data. (auth)

10894 (LA-tr-71-74) RADIATIVE CAPTURE OF NEUTRONS BY ^{241}Am. Dovbenko, A. G.; Ivanov, V. I.; Kolesov, V. E.; Tolstikov, V. A. Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from Byull. Tsentra Yadern. Dannym; No. 6, 42-6(1969). 9p. Dep. NTIS.

The cross sections and isomeric cross section ratios for the capture of thermal and reactor-spectrum neutrons by ^{241}Am were determined from a study of the induced alpha activity. The results were compared with calculations made using the statistical theory of nuclear reactions. (J.W.R.)

10895 (LIB/Trans-388) STUDY OF THE NEUTRON EMISSION OF ^{252}Cf FISSION FRAGMENTS AS A FUNCTION OF THEIR CHARGE. Nifenecker, H.; Frehaut, J.; Soleilhac, M. Translated by P. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Symposium on the Physics and Chemistry of Fission, 2nd, Vienna, 1969. 14p. (CONF-690708-9). Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA 24: 30791 (1970). (Australia)

10896 (N-71-29765) STUDY OF THE (α,t) REACTION ON ^{90}Zr, ^{92}Mo, AND ^{96}Mo AT 41.5 MeV. Priest, Joseph R.; Vincent, John S.; Julian, Glenn M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jul 1971. 15p. (NASA-TN-D-6413). NTIS.

Angular distributions for the (α,t) reactions on ^{90}Zr, ^{92}Mo, and ^{96}Mo leading to the ground states of ^{91}Nb, ^{93}Tc, and ^{97}Tc were measured from 15 to 60° for an alpha particle energy of 41.5 MeV. The distorted wave Born approximation calculation for the stripping of an l = 4 proton provides an adequate description of the angular distributions. The spectroscopic strengths agree favorably with those deduced from a similar study using the (He-3,d) reaction. These results are consistent with a model which envisions the ground states of ^{91}Nb, ^{93}Tc, and ^{97}Tc as a $1g_{9/2}$ proton coupled to a 0(+) core. (auth) (STAR)

10897 (NP-19049) EXPERIMENTAL STUDIES ON THE LEVEL STRUCTURES OF SOME SPHERICAL EVEN-EVEN NUCLEI. Liukkonen, Esko (Helsinki Univ. (Finland). Dept. of Physics). 1971. 7p. Dep. NTIS (U. S. Sales Only).

The level structure of the vibrational nuclides krypton-82, palladium-106, and tin-118 and -120 is reviewed. The beta decays of adjacent odd–odd nuclei are used in the study. A new 8.5-sec isomer in indium-118 was found and its spin and parity are given. (J.F.P.)

10898 (NP-19057) STUDIES OF PROMPT GAMMA RADIATION FROM FISSION FRAGMENTS. Albinsson, H. (Chalmers Tekniska Hogskola, Goteborg (Sweden)). 1971. 44p. Dep. NTIS (U. S. Sales Only).

Gamma radiation emitted from fission fragments with a half-life shorter than 10^{-9} s was studied. Most studies were performed on spontaneous fission of ^{252}Cf and to a lesser extent on the slow neutron induced fission of ^{235}U. The experimental set up is described in detail. Its two main features are a gamma collimator, which selects different time intervals after the fission event, and the time-of-flight technique. Investigations were made of gamma ray spectra as functions of mass and time after fission, of yield of photons as a function of the total kinetic energy of the fragments and of the intensity distributions of the prompt fission gamma radiation as a function of time after fission. The latter investigation has permitted the derivation of decay curves and values of half-lives. The gamma-ray energy associated with different half-lives is shown to be very different. (Sweden)

10899 (NP-19068) PROGRESS REPORT, 1970–1971. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 102p. Dep. NTIS (U. S. Sales Only).

ALUMINUM-27—electron elastic scattering at 40 to 90 MeV, magnetic form factor for, (E)
ARGON-38—energy-level scheme from chlorine-38 decay, (E)
BERYLLIUM-9—deuteron elastic scattering at 26 MeV, angular distributions for, (E)
—proton reactions (p,dα) at 51 MeV, Dalitz plot for, (E)
—deuteron reactions (d,tα) at 26 MeV, Dalitz plot for, (E)
—alpha reactions (α,2α) at 52 MeV, alpha spectra from, (E)
CARBON-12—helium-3 elastic scattering at 70 MeV, angular distributions for, (E)
CERIUM-137—energy-level scheme from (α,xn) reactions, (E)
CERIUM-138—energy-level scheme from praseodymium-138 decay, (E)
—energy-level scheme from (α,xn) reactions, (E)
CERIUM-139—energy-level scheme from (α,xn) reactions, (E)
CHLORINE-38—energy-level scheme from sulfur-38 decay, (E)
CHROMIUM-52—electron inelastic scattering at 80 MeV, electron spectra from, (E)
DEUTERIUM—deuteron reactions (d,pd) at 26 MeV, Dalitz plot and correlated energy spectra for, (E)
—proton reactions (p,2p) at 51 MeV, correlated energy spectra from, (E)
GOLD-197—helium-3 reactions (He-3,pd), (He-3,pt), (He-3,2d), and (He-3,2p) at 69 MeV, correlated energy spectra from, (E)
HYDROGEN—helium-3 reactions (He-3,pd) at 70 MeV, proton spectra from, (E)
INSTRUMENTS—development at Instituut voor Kernphysisch Onderzoek
NEODYMIUM-139—energy-level scheme from (α,xn) reactions, (E)
NEODYMIUM-140—energy-level scheme from (α,xn) reactions, (E)
NEODYMIUM-141—energy-level scheme from (α,xn) reactions, (E)
PLUTONIUM-238—energy-level scheme from americium-238 decay, (E) (J.W.R.)

10900 (NYO-2028-6) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MOESSBAUER STUDIES. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Oct 1971. Contract AT(30-1)-2028. 118p. Dep. NTIS.

The Moessbauer effect following Coulomb excitation has been used to determine the change in nuclear radius in the first excited states of ^{182}W and ^{184}W. Isomer shifts of .034 ± .022 mm/sec and −.055 ± .030 mm/sec were measured for ^{182}W and ^{184}W. This leads to a change in nuclear radius, $\Delta R^2/R^2$ of $-.25 \pm .18 \times 10^{-4}$ and $.19 \pm .12 \times 10^{-4}$ respectively. The rather poor statistics for ^{186}W prevent a valid determination of $\Delta R^2/R^2$. (auth)

10901 (ORNL-4705) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1971. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 115p. Dep. NTIS.

CONCRETES—neutron absorption in, total and γ-ray dose equivalents for 15- to 75-MeV
ETHYLENE POLYMERS—neutron absorption in, γ spectra from pulsed, (E)
INFORMATION CENTERS—activities of ORNL Radiation Shielding
IRON-54—neutron reactions (n,xγ) at 5.4 MeV, γ spectra from, (E)
LEAD—neutron reactions up to 20 MeV, evaluated cross sections for
PLUTONIUM-239—neutron absorption up to 400 keV, cross section for, (E)
—neutron fission up to 400 keV, cross section for, (E)
PLUTONIUM-241—neutron capture and fission cross section up to 10 keV, (E)
RADIATION DETECTORS, SCINTILLATION (LIQUID)—response function of NE-213, for 30-MeV neutrons
TANTALUM-181—neutron inelastic scattering up to 15 MeV, statistical calculation of γ spectra from, (T)
TISSUES—meson (π^-) absorption for, calculation of depth-dose distributions for
URANIUM-235—neutron absorption up to 400 keV, cross section for, (E)
—neutron fission up to 400 keV, cross section for, (E)
—neutron capture and fission cross sections up to 100 keV, (E)
—neutron capture up to 60 eV, Reich–Moore multilevel analysis of, (T)
—neutron fission up to 60 eV, Reich–Moore multilevel analysis of, (T)
URANIUM-238—neutron reactions up to 1140 eV, transmission data for, (E) (J.W.R.)

10902 (ORNL-4706) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 20, 1971. Moore, G. E. (ed.) (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 277p. Dep. NTIS.

A separate abstract was prepared for each of the seven sections included. (D.H.M.)

For abstracts of individual sections see: 8787, 8864, 8879, 9017, 10018, 10831, and 10903.

10903 (ORNL-4706, pp 32-90) CHEMISTRY AND PHYSICS OF TRANSURANIUM ELEMENTS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Chemistry Division annual progress report for period ending May 20, 1971.

Some previously unreported data on the following subjects are presented: proton interactions with ^{231}Pa and ^{232}Th, alpha Coulomb excitation of rotational bands in even–even transuranium nuclei, half-lives of ^{246}Cm and ^{248}Cm, thermal capture cross sections and resonance integrals of ^{249}Cf, ^{250}Cf, ^{251}Cf and ^{252}Cf, K x rays from curium, berkelium, californium, and einsteinium, L x rays from uranium, ^{255}No decay, crystal and molecular structure of samarium triindenide and triindenyluranium chloride, crystallographic studies, ionic radii from transplutonium trichlorides, and design of a neutron multiplicity counter. (J.W.R.)

10904 (ORO–3921-16) NUCLEAR SPECTROSCOPY. Progress Report, January 1–November 30, 1971. Sugihara, T. T.; Watson, R. L. (Texas Agricultural and Mechanical Univ., College Station. Cyclotron Inst.). Contract AT(40-1)-3921. 80p. Dep. NTIS.

Levels in ^{152}Gd show quasi-rotational character while in ^{150}Gd the energies of low-lying levels are those expected of a vibrator. An unusual set of negative-parity levels was observed in ^{150}Gd. The structure determinations were made by decay studies of high-spin isomers of Tb and by in-beam xnγ spectroscopy. Band mixing was found in ^{174}Hf and in ^{186}Os to be described by a first-order perturbation treatment of rotation–vibration mixing. A method for quickly transporting nuclear-reaction products to a low-background area for γ-ray spectroscopy was developed. The method is based on the helium-jet recoil-sweeping technique originated by Macfarlane [Nucl. Instrum. Methods, 24: 461(1963); 73: 285(1969)]. Experiments directed at the investigation of x-ray production by high-energy alpha particles and deuterons established the existence of substantial deviations from the projectile charge dependence predicted by the Born approximation theory and the Binary Encounter Model, resulted in the determination of K- and L-shell x-ray production cross sections for a wide range of elements, and led to the observation of multiple ionization effects associated with energy-level matching between the projectile and the target atoms. In a study of x-ray production in fission fragment collisions, K x-ray spectra from Ni, K, and Br targets and the L x-ray spectrum from a Au target were examined. Observed x-ray energy shifts were interpreted as resulting from multiple inner-shell plus outer-shell ionization with the aid of Hartree–Fock–Slater calculations. A detailed investigation of internal ionization during the β decay of ^{147}Pm and ^{99}Tc resulted in accurate determinations of the total internal ionization probabilities and an examination of the energy dependence of the process. (auth)

10905 REMARKS ON THE ^{115}In(n,n′)^{115m}In CROSS-SECTION CURVE. Pauw, H.; Aten, A. H. W. (Instituut voor Kernphysisch, Amsterdam). J. Nucl. Energy; 25: No. 9, 459-60(Sep 1971).

The excitation curve for the ^{115}In(n,n′)^{115m}In reaction was renormalized using a renormalized ^{197}Au(n,γ)^{98}Au excitation curve and a cross-section curve for the ^{235}U(n,f) reaction. The average cross section for the ^{115}In(n,n′)^{115m}In reaction was measured with neutrons from ^{9}Be(α,n) sources, data on the spectra of which were obtained by (n,α) activation measurements for In and Au and by track registration of fission fragments of ^{238}U, ^{237}Np, and ^{239}Pu. These activation measurements showed that the fraction of neutrons calculated to be above 1.0 MeV from the renormalized cross-section curve for the ^{115}In(n,n′)^{115m}In reaction was too high. A 13% increase in the average cross sections for the reaction gave reasonable results. (UK)

10906 REMARKS ON THE ^{252}Cf SPECTRUM. Pauw, H.; Aten, A. H. W. (Instituut voor Kernphysisch, Amsterdam). J. Nucl. Energy; 25: No. 9, 457-9(Sep 1971).

Using a Cf neutron source, the following activation reactions were measured: ^{115}In(n,γ)^{116m}In (54 min), ^{115}In(n,n′)^{115m}In, ^{197}Au(n,γ)^{198}Au, ^{197}Au(n,2n)^{196}Au, ^{238}U(n,f), ^{237}Np(n,f) and ^{239}Pu(n,f). The measurements were used to obtain data on the low and high energy parts of the Cf neutron spectrum. The higher part was checked by measurement of the ^{197}Au(n,2n)^{196}Au reaction. (UK)

10907 NUCLEAR MATRIX ELEMENTS FOR THE $7/2^- \rightarrow 7/2^+$ BETA TRANSITION IN ^{141}Ce. Bosch, H. E. (Univ., Buenos Aires); Behar, M.; Cambiaggio, M. C.; (and others). Lett. Nuovo Cim.; 2: No. 14, 681-5(2 Oct 1971).

The spectrum shape factor and beta–gamma angular correlation anisotropy coefficient for the $7/2^- \rightarrow 7/2^+$ beta transition in ^{141}Ce were measured. The results were used along with previous data to extract the nuclear matrix elements for the $7/2^- \rightarrow 7/2^+$ transition. (J.W.R.)

10908 NEUTRON ABSORPTION CROSS SECTIONS FOR ^{94}Zr AND ^{96}Zr. Fulmer, R. H.; Stricos, D. P.; Ruane, T. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 46: No. 2, 314-17(Nov 1971).

Neutron absorption cross sections for ^{94}Zr and ^{96}Zr were measured by an activation technique. Absolute gamma-ray counting of the radioactive daughters, with a Ge(Li) detector-multichannel analyzer system, yielded disintegration rates which were calibrated in terms of cross section with gold samples. Results, in barns, for 2200 m/sec cross sections and resonance integrals are ^{94}Zr, 0.052 ± 0.003, 0.30 ± 0.03; ^{96}Zr, 0.020 ± 0.003, 5.0 ± 0.4, respectively. The low value of the ^{96}Zr thermal cross section requires that the resonance at 301 eV be p wave. (auth)

10909 K- AND L-SHELL INTERNAL CONVERSION COEFFICIENTS OF THE 256 AND 139 keV γ-TRANSITIONS FROM ^{151}Nd. Nainan, T. D. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Nuovo Cim.; 5A: No. 4, 544-50(21 Oct 1971).

A Ge(Li) gamma-ray spectrometer and a Si(Li) electron spectrometer were standardized for internal conversion coefficient measurements using gamma-transitions of well-determined α_k and K/L values from standard sources. The internal conversion coefficients of four gamma-transitions following the 12 minute β-decay of ^{151}Nd were determined by using this standardized spectrometer. (auth)

10910 REACTIONS INDUCED IN Au BY 10 TO 70 MeV DEUTERONS. Chevarier, N.; Chevarier, A.; Demeyer, A.; Tran Minh Duc (Lyon Univ., Villeurbanne, France). J. Phys. (Paris); 32: No. 7, 483-90(Jul 1971). (In French).

Excitation functions were determined for reactions induced in Au by deuterons up to 70 MeV. Isomer ratios were measured for (d,2n)(d,4n), (d,p2n) reactions. The (d,xn) excitation functions were interpreted with a statistical model including evaporation and precompound emission. The Huizenga–Vandenbosch calculation method gives good agreement for isomer ratios with (d,2n) and (d,4n) reactions in the range of energy corresponding to compound nucleus processes. The excitation function and the isomer ratio of the (d,p2n) reaction demonstrate that it is principally a transfer reaction. (France)

10911 THERMAL-NEUTRON-INDUCED TERNARY FISSION OF ^{235}U. De Bruyne, P. Int. J. Appl. Radiat. Isotop.; 22: No. 11, 647-52(Nov 1971). (In French).

In order to obtain further evidence for or against the existence of ternary fission, in which a heavy nuclide fragments into three large charged particles, in place of the usual two, radiochemical yields were sought. The possibility of slow neutron fission of ^{235}U in three fragments has been studied by many investigators with a variety of techniques. The tripartition into three comparable mass fragments should however not be confused with the more frequently occurring fission process in which a light charged particle (predominantly an alpha particle) is simultaneously emitted. It may be concluded that additional evidence is required to establish with certainty the occurrence of tripartition and that the frequency of such events must be very low: the yield is probably less than 10^{-10}. Identification of a radionuclide which cannot be produced by reactions other than fission should provide evidence for the process. Of course, the formation of such a product by binary fission should also be ruled out. (auth)

10912 NUCLEAR PHYSICS WITH THE HIGH FLUX REACTOR OF THE LAUE-LANGEVIN INSTITUTE. Moussa, Andre (Institut Max von Laue–Paul Langevin, Grenoble, France). Centre d'Etudes Nucleaires, Grenoble, France). Ind. At.; 15: No. 2, 53-64(May 1971). (In French).

The Laue–Langevin institute which was created in 1967 by the French and Federal German governments is installing a high flux output reactor at Grenoble which will be used principally for neutron solid state physics. Part of the program concerns nuclear physics research. Radiative capture of neutrons will be studied by gamma ray spectrometry using a high precision curved crystal spectrometer, by magnetic spectrometry of the conversion electrons, and by semiconductor spectrometers. Two channels of the reactor are reserved for these studies. Fission will be studied using a mass separator installed in a special channel of the reactor; this instrument will analyze the fission products without slowing them down. The output neutron beams, particularly those provided by the total reflection guides, will be used for various capture or fission experiments, and for studying the neutron itself: β disintegration, search for a dipolar electric moment. The performance of this reactor with regard to the intensity, purity of the neutron flux, and the background noise, is for all these experiments distinctly better than that of existing reactors. (France)

10913 ANGULAR-CORRELATION STUDIES IN ^{99}Tc. Jagam, P.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Indian J. Phys.; 43: No. 12, 713-24(Dec 1969).

The combined angular correlation pattern of the cascades 740-180 and 740-(40)-140 keV is studied by the sum-peak-coincidence technique using a fast-slow coincidence scintillation

spectrometer and a 100 channel analyzer. Assuming equal admixture of the cascades and the spins of the ground 140 and 180 keV states in ^{99}Tc to be $^{9}/_{2}$+, $^{7}/_{2}$+ and $^{5}/_{2}$+ respectively, the observed correlation pattern indicated a spin assignment of $^{1}/_{2}$+ for the 920 keV state. (auth)

10914 COLLECTIVE MODELS OF A GIANT DIPOLE RESONANCE OF A NUCLEAR TRANSITION. Kostin, M. N.; Semenko, S. F.; Tulupov, B. A. Kratk. Soobshch. Fiz.; No. 4, 22-7(Apr 1971). (In Russian).

In the low-energy portion of a dipole peak the experimental cross section always exceeds the theoretical; one reason for this deviation might be the perfection of the model used to represent movement of the surface of the nucleus. Employing the simple mathematical model of A. S. Davydov and A. A. Chaban, the photo-absorption curve characterizing the 2^+-level of the nucleus ^{150}Sm was calculated and compared with the corresponding experimental curve. Both curves had a similar maximum in the low-energy end; however, the theoretical curve failed to reproduce the giant resonance. (K.S.W.)

10915 RESEARCH IN NUCLEAR PHYSICS WITH FAST NEUTRONS. Kiss, Adam (Lorand Eoetvoes Univ., Budapest). Fiz. Szemle; 19: No. 7, 193-9(Jul 1971). (In Hungarian).

The experimental methods used in fast-neutron research and the information obtained are reviewed. The means used to generate fast neutrons are examined. Radioactive sources do not yield a monoenergetic beam and often have a strong γ background. In photoneutron sources, the γ quanta or x radiation may generate fast neutrons by a (γ,n) reaction. The most widely used research tool is based on the bombardment of a target by an accelerated particle beam. The ^{2}H(d,n)^{3}He + 3.3 MeV and ^{3}H(d,n)^{4}He nuclear reactions have a Coulomb barrier and are well suited to generate fast neutrons. The experiments usually involve the determination of the probability of a certain reaction, the directional and energy distribution and polarization of the emitted particles. The reaction products must be detected in the presence of the bombarding flux. The scattering target and the charged-particle detector must be separated from each other in order to be able to determine the angular distribution of the generated charged particles. The energy distribution of the neutrons resulting from elastic or inelastic scattering of fast neutrons may be derived only indirectly from an induced (n,charged particle) reaction in the target. The time-of-flight technique requires measurements of periods in the tens of nanosecond range. Application of the statistical model to demonstrate the shell effect is examined. Research with fast neutrons is also of interest for the clarification of nuclear spectroscopic problems and to elucidate the structure of the nucleus. (TTT)

10916 SLOW NEUTRON CAPTURE CROSS SECTIONS FOR THE LONG-LIVED ACTIVITIES, ^{171}Er AND ^{171}Tm. Miyano, Kazumasa (Niigata Univ., Japan). J. Phys. Soc. Jap.; 31: No. 5, 1304-5(Nov 1971).

The slow neutron capture cross section for ^{171}Er was obtained to be $(2.8 \pm 0.3) \times 10^{2}$ barns by irradiating natural Er with the high flux pile. The (n,γ) reaction cross section for ^{171}Tm, far from the stable isotope ^{169}Tm, was determined to be $(1.6) \times 10^{2}$ barns in this irradiation. (auth)

10917 PARAMETRIC FIT OF THE NEUTRON CROSS SECTION OF HOLMIUM. Stephenson, Thomas E.; Ferrer, Alberto M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 46: No. 2, 266-73(Nov 1971).

Resonance parameters for 74 resonances of ^{165}Ho below 500 eV, selected from the literature and from values compiled and recommended in BNL-325, are used as the starting point in fitting the total neutron cross-section data to a sum of the Breit–Wigner multilevel scattering and single-level capture formulas. The addition of two bound levels, one for each s-wave spin state, yields a calculated ratio of thermal neutron capture cross sections for the two s-wave spin states which agrees with experiment (~60% of thermal capture into J = 3 states), as does the calculated value of the thermal capture cross section, 67 b. In addition, the two bound levels enable the fit of the total cross-section data to be extended to very low energies (0.2 mV). The coherent scattering cross section has been calculated and is in good agreement with the experimental value of 9.1 b. The free atom nuclear scattering cross section has been calculated to be 10.6 b. The calculated value of the potential scattering is 7.8 b and the effective scattering radius is 7.9 f. The energy-dependent paramagnetic scattering cross section (23.5 b at 0.0253 eV) and the capture and scattering resonance integrals have also been calculated (~703 and 125 b, respectively). (auth)

10918 USEFUL ENERGY RELEASED IN THE FISSION OF ^{232}Th, ^{233}U, ^{234}U, ^{236}U, ^{237}Np, ^{238}Pu, ^{240}Pu, AND ^{242}Pu. James, M. F. (Atomic Energy Establishment, Winfrith, Eng.). J. Nucl. Energy; 25: No. 10, 513-23(Oct 1971).

The total effective energy released is calculated from atomic mass excesses, and a detailed discussion is given of a method of interpolation used when data on fission product yields are sparse or non-existent. A comparison is made between calculated values and the few experimental measurements that were made for the nuclides under consideration. Reasonable agreement was obtained, although the discrepancy between time-of-flight and solid state detector measurements of fission fragment kinetic energies were again noted. Recommended values for the useful energy released from fission, and for the total useful energy per fission in a thermal neutron reactor, including contributions from neutron capture, are given for ^{232}Th, ^{233}U, ^{234}U, ^{236}U, ^{237}Np, ^{238}Pu, ^{240}Pu, and ^{242}Pu. Values for ^{233}U and ^{238}Pu are for fission induced by thermal neutrons; for the other nuclides the incident neutrons are assumed to have the spectrum of fission neutrons from ^{235}U. (UK)

10919 IMPLIED SUPERHEAVY ELEMENT DECAY LIFETIME FROM METEORITES. Schramm, D. N. (California Inst. of Tech., Pasadena). Nature (London); 233: No. 5317, 258-9 (24 Sep 1971).

It was demonstrated by Schramm and Fowler (Nature 231: 103 (1971)) that superheavy elements could be synthesized in the r-process, and in this connection it was thought interesting to consider the anomalous heavy Xe isotopic composition of carbonaceous chrondrites. It had been shown by Rowe (Geochim. Cosmochim. Acta 32: 1317 (1968)) that these isotopic anomalies could be caused by the fission of some unknown nucleus, and a reasonable candidate for this unknown fissioning nucleus would be a long-lived superheavy element. Assuming this to be the case it is possible to estimate the half-life of the superheavy element using the calculations of Schramm and Fowler and the interval (Δ) between the termination of nucleosynthesis and the time of Xe gas retention. Ranges of values for Δ were calculated, together with the implied abundance ratio of the superheavy element relative to ^{244}Pu. The question as to whether the fission is symmetrical, asymmetrical, or even tertiary is discussed. It is estimated that the limits for the half-life of the superheavy element (τ_{SH}) that can be placed from the Xe results are 1.65×10^{7} yr $\leq \tau_{SH} \leq 6.80 \times 10^{7}$ yr. (UK)

10920 HINDRANCE FACTOR OF THE E2 $6^+ \rightarrow 4^+$ TRANSITION IN ^{146}Gd. Filevich, A.; Kownacki, J.; Ryde, H. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A176: No. 1, 155-60 (1971).

Using the ^{144}Sm(α,2n) reaction and the natural beam bunches from the Stockholm 225 cm cyclotron, the half-life of the 2983 keV state (6^+) in the semi-closed shell nuclide ^{146}Gd is determined to be 13.5 ± 3.5 ns. (auth)

10921 PROSPECTS FOR MAKING NEW TRANSURANIUM ELEMENTS. Tolar, Jiri. Pokroky Mat. Fyz. Astron.; 16: No. 4, 187-91(1971). (In Czech).

The possibilities of synthesizing additional transuranium elements are discussed. After a discussion of the synthesis of Pu, Am, and Cm, the elements Bk, Cf, Es, Fm, Md, No, and Lw (elements 97 through 103) and the dates of their synthesis are mentioned, along with kurchatovium (104) and hahnium (105). Nuclear equations for synthesizing elements 114 and 116 are given, for example, ^{252}Cf + ^{48}Ca → ^{294}116, and possible half-lives are suggested. (13 references, 10 in English) (TTT)

10922 DETERMINATION OF THE RESONANCE INTEGRAL OF ^{109}Ag. Mincheva, L.; Stanolov, A. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 109-15(1971). (In Bulgarian).

The activation resonance integral of ^{109}Ag was determined experimentally by means of the activation method using a set of silver plates with $1 < \rho x < 50$ mg/cm^2. The investigations were carried out in the eighth vertical channel of the reactor IRT-1000 in Sofia with a power of 1800 kW. For the activation resonance integral of ^{109}Ag the value I_{res} = (56.05 + 1.721) barns is obtained, determined by a 3% statistical error on the starting data: $\sigma^{th}_{act}(s)$ = 96 barn, $I_{res}(s)$ = 1558 barn, and $\sigma^{th}_{act}(x)$ = 4.27 barn. With a view to the importance of the constant investigated, all possible sources of errors are analyzed, and the corresponding corrections are made. The value obtained for the activation resonance integral is compared with the data of the only published paper by Macklin and Pomeranse, in which, however, the resonance integral of trapping for ^{109}Ag is determined by the activation method. (auth)

10923 APPROXIMATE GRAPHICAL DETERMINATION OF THE ACTIVITY OF GENETICALLY CONNECTED ISOTOPES BY DECAY CONSTANTS OF ONE AND THE SAME ORDER. Mikhailov, M. K.; Mazhkarov, S. A.; Mikhailov, M. I. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 165-74(1971). (In Bulgarian).

An approximate graphical method for determining the activities and the isotopic relation of the genetically connected pairs of isotopes in activation and decay is found. For each genetically connected pair of isotopes curves are first made of the ratio of the number of radioactive atoms for the corresponding isotope to the rate of growth, entered for the time of activation and decay. This is achieved by using the relations theoretically derived from the solutions of the appropriate linear differential equations. For illustration of the graphical method, the graphs of the genetic pair of isotopes ^{197m}Hg are plotted. The difference between the values determined by formulas and those by the graphical method give the relative percentage error. It is calculated for differential cases. The limit for the application of the method is determined, too. The method finds application in serial production of isotopes, and is useful when the activation is carried out frequently. (R.W.R.)

10924 SUPERFLUID PROPERTIES OF NUCLEI IN REGION $100 < A < 256$. Khristov, I. D.; Garistov, V. P. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 133-40(1971).

Pairing energies for spherical and deformed nuclei (in the region $100 < A < 256$) are calculated on the basis of the superfluid model of the nucleus. The Nilsson scheme is chosen as one-particle equations of an average field. The pairing energies, calculated with the constants $G_N = 23A^{-1}$ and $G_Z = 27A^{-1}$ in the $150 < A < 256$ region and $G_N = 17A^{-1}$ and $G_Z = 20A^{-1}$ in the $100 < A < 150$ region, agree sufficiently well with the experimental data. The correlation functions and chemical potentials are obtained. The data obtained can be used for estimation of many physical processes in intermediate and heavy nuclei. (auth)

10925 KINETIC ENERGY VARIATION OF FRAGMENTS OF ^{235}U FISSIONED BY 0.006- TO 20-eV NEUTRONS. Bochvarov, S.; Dermendzhiev, E.; Kashukeev, N. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 87-97(1971). (In Russian).

The kinetic-energy variation was studied for the thermal range and for the resonances of ^{235}U by the method of measuring the relative yield of W fragments from two targets different in thickness by using the neutron spectrometer of the Neutron Physics Laboratory (JINR) in the energy range 0.006 to 20 eV. It was found that the resonances at 0.29, 2.04, 3.14, 4.84, and 7.09 eV can be collected into the group with smaller value of W and, consequently, E_k; while the resonances at 1.14, 3.60, 6.40, 8.78, 12.4, and 19.3 eV can form the group with larger W and E_k. The comparison of the values W with the radiochemical data on the fission-fragment yield in the thermal range and in ^{235}U resonances shows that, evidently, $\overline{E}_k$ is larger at more asymmetric fission. From the values $\overline{W}$(I) and $\overline{W}$(II) for two resonance groups the variation of the average total kinetic energy of the fragment was found to be $2\Delta\overline{E}_k = 0.74 \pm 0.32$ MeV. (auth)

10926 DECAY SCHEME OF ^{166}Tm. Mandzhukov, I.; Mandzhukova, B.; Burin, K.; Strigachev, At. God., Sofii. Univ., Fiz. Fak.; 63: 91-7(1968-1969). (In Russian).

The decay scheme of ^{166}Tm has been studied on a β-spectrograph with a semi-circular focusing arrangement and a photographic way of recording. The effective radius of the camera was 18 cm with a resolution of about 0.06%. The sensitive volume of the Ge(Li) detector was 22 cm^3 with a resolution of 5 keV. The results of the investigation are summarized in tables. (auth)

10927 NUCLEAR DATA SHEETS FOR A = 205. Schmorak, M. R. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 6: No. 4, 425-51(Oct 1971).

The available experimental data pertaining to the nuclear structure of nuclei with A = 205 are compiled; the results from various decay and reaction measurements are compared and evaluated. Inconsistencies and discrepancies in the level schemes are discussed. Level properties, gamma-ray properties, and comments are presented following the data on the relevant nucleus. (auth)

10928 NUCLEAR DATA SHEETS FOR A = 200. Martin, M. J. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 6: No. 4, 387-424(Oct 1971).

Detailed level schemes and the experimental reaction and decay data on which they are based are presented for all the nuclei with mass number A = 200. The experimental data are evaluated, inconsistencies and discrepancies are noted, adopted values for level and gamma energies, gamma intensities and other nuclear properties are given. Conclusions regarding spin assignments are presented. (auth)

10929 NUCLEAR DATA SHEETS FOR A = 199. Lewis, M. B. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 6: No. 4, 355-86(Oct 1971).

Level schemes, spin and parity assignments, and decay properties are presented for all nuclei with mass number A = 199. Experimental data and adopted values are given along with conclusions as to the spin and parity assignments. The presentation of the nuclear properties is given in the light of the data and current theoretical ideas. In this transition region, level decay rates are seen to be of particular importance and so have been summarized in terms of multipole enhancement and hindrance. There are no transfer reaction data leading to ^{199}Au, and the inelastic scattering data on ^{199}Hg are very incomplete. Compilers have attempted to bring out some inconsistencies in the data and resolve discrepancies when possible. (auth)

10930 LOW-LYING NEGATIVE-PARITY STATES IN THE VIBRATIONAL NUCLEI. Vogel, P. (California Inst. of Tech., Pasadena); Kocbach, L. Contract AT(04-3)-63. Nucl. Phys.; A176: No. 1, 33-46(1971).

Properties of the negative-parity quintuplet of states $I^\pi = 1^- - 5^-$ are calculated. The states can be interpreted as one-quadrupole + one-octupole phonon states. A simplified version of the time-dependent Hartree–Fock method is used to obtain parameters of the collective Hamiltonian. The equation of motion is then solved in a truncated space of harmonic phonon wave functions. The numerical calculations are made for nuclei with $140 \leq A \leq 148$. The resulting spectra show the effect of gradual increase of anharmonic corrections when the corresponding quadrupole and octupole phonons become more collective. (auth)

10931 NUCLEAR DATA SHEETS FOR A = 198. Auble, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 6: No. 4, 319-53(Oct 1971).

Nuclear structure data for mass 198 nuclei are compiled, and adopted level and gamma-ray properties are presented. The adopted values are based on all data available through June 1971. Inconsistencies in the data on ^{198}Au and ^{198}Pb are noted. (auth)

10932 WHAT IS THE HALF-LIFE OF ^{132}Cs? Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys.; 21: No. 6, 877-8(Dec 1971).

A source of about 14 μCi of ^{132}Cs, widely used for calibration of whole-body counters for ^{137}Cs, was studied to determine the half-life and identify impurities. Gamma ray spectra (35 to 1000 keV) are presented from the ^{132}Cs source at various times, showing the gradual appearance of the longer lived impurities ^{83}Rb and ^{134}Cs and the disappearance of the shorter-lived ^{84}Rb. (UK)

10933 CHARGE DISTRIBUTION AND RECOIL PROPERTIES IN THE FISSION OF ^{208}Pb BY 11.5-GeV PROTONS. Panontin, J. A.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). J. Inorg. Nucl. Chem.; 33: No. 10, 3211-22(Oct 1971).

Cross sections and thick-target recoil properties were determined for a number of products in the mass region 100 to 113 from the interaction of ^{208}Pb with 11.5 GeV protons. The recoil ranges of the neutron deficient products are approximately a factor of two smaller than those of the neutron excessive products suggesting a difference in reaction mechanisms. On the basis of this result a charge dispersion curve consisting of two gaussians, peaking at $N/Z = 1.24$ and 1.34, was constructed to fit the measured cross sections of the A = 111 isobars. The resulting curve is single-peaked but has a pronounced shoulder on the neutron excessive side. The curve for the neutron excessive products is very similar to that obtained in the fission of ^{208}Pb by 450 MeV protons except for a reduction in the value of the integrated cross section. The values of the average deposition energy, average total kinetic energy of the primary fragments, and average separation distance at scission obtained for these products from their recoil properties are nearly equal to the corresponding values at 450 MeV. Integration of the charge dispersion curve for the neutron deficient products indicates an 82% contribution to the total isobaric cross section at A = 111. Comparison of the properties of the neutron deficient products with similar results previously obtained for a ^{238}U target as well as with evaporation calculations indicates that only a fragmentation mechanism can explain all the experimental results. (auth) (UK)

10934 HALF-LIFE OF ^{172}Hf. Chu, Y. Y. (Brookhaven National Lab., Upton, N. Y.); Karol, P. J. Inorg. Nucl. Chem. Lett.; 7: No. 12, 1205-7(Dec 1971).

Two types of samples were used in the half-life determination: an isotopically pure mass 172 sample and a chemically pure hafnium sample. The methods of sample preparation are indicated. For the former, sample measurements were made several times each month over a period of more than two years and from the decay curve of the x rays a half-life for ^{172}Hf of 1.83 ± 0.03 yr was obtained. For the second sample the decay of the 125 keV γ ray of ^{172}Hf and the growth and decay of the 182 keV γ ray of ^{172}Lu were measured over a period of 10 months giving an average value of $2.04 + 0.11$ yr. The weighted average of the two measurements based on the inverse square of their respective uncertainties gave 1.87 ± 0.03 yr as the half-life of ^{172}Hf. (UK)

10935 DETERMINATION OF THE HALF-LIVES OF ^{246}Cm AND ^{248}Cm BY ABSOLUTE SPECIFIC ACTIVITY TECHNIQUES. McCracken, J. E.; Stokely, J. R.; Baybarz, R. D.; Bemis, C. E. Jr.; Eby, R. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 10, 3251-9(Oct 1971).

The partial α half-lives for ^{246}Cm and ^{248}Cm and the partial spontaneous fission half-life for ^{248}Cm were determined by an absolute specific activity method. The measured values are $(4.655 \pm 0.040) \times 10^3$ yr for $t_{1/2}(\alpha)$ for ^{246}Cm; $(3.703 \pm 0.032) \times 10^5$ yr for $t_{1/2}(\alpha)$ for ^{248}Cm; and $(4.115 \pm 0.034) \times 10^6$ yr for $t_{1/2}$(SF) for ^{248}Cm. (auth) (UK)

10936 MASS YIELDS OF ^{241}Am THERMAL-NEUTRON FISSION. Nakahara, Hiromichi; Fujiwara, Ichiro; Okamoto, Hironobu; (and others) (Kyoto Univ.). J. Inorg. Nucl. Chem.; 33: No. 10, 3239-50(Oct 1971).

Mass yields of sub-threshold fission induced by thermal neutrons were investigated, namely, mass yields of 23 mass chains were determined for ^{241}Am thermal-neutron fission by the conventional radiochemical method and by the direct γ-ray spectrometry method. The peak-to-trough ratio in terms of ^{99}Mo/^{117}Cd was found to be as large as 800 ± 200. Three fission systems of spontaneous fission, sub-threshold fission and above-threshold fission with the compound mass $A_F = 242$ were compared and discussed. The average number of neutrons released per fission was evaluated to be 4.0 ± 0.2 from the mass yield curve. (auth) (UK)

10937 STUDY OF THE LANTHANIDE RECOIL PRODUCTS ARISING FROM THE INTERACTION OF HIGH-ENERGY PROTONS WITH TANTALUM NUCLEI. II. CROSS SECTIONS OF THE LANTHANIDES FOR A PROTON ENERGY OF 19 GeV. Neidhart, B.; Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). J. Inorg. Nucl. Chem.; 33: No. 10, 3227-32(Oct 1971). (In German).

Foils of tantalum were irradiated using 19 GeV protons, and the rare earth elements were chemically isolated. The independent or cumulative cross sections for the formation of about 30 lanthanide nuclides were determined. The experimentally measured σ-values are compared with the theoretical σ-values which were calculated using the Rudstam spallation formulas. Good agreement was obtained for the charge dispersion of the Eu-isotopes by variation of the parameters. However, the calculated yield-vs-mass curve disagrees with the experimentally determined curve. It is unlikely that the nuclides in question are formed by spallation. It is assumed that (at 19 GeV proton energy) the rare earth nuclides are residual nuclei of a fragmentation process. The charge dispersion of the residual nuclei is described by a Gaussian distribution. (auth) (UK)

10938 MEASUREMENT OF THE RATIO OF THE QUADRUPOLAR MOMENTS OF TWO EXCITED LEVELS OF THE ^{133}La NUCLEUS. Deleplanque, M. A.; Gerschel, C.; Perrin, N.; Rimbert, J. N.; Valentin, L. (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 273: No. 13, 565-7(27 Sep 1971). (In French).

The coexistence of two different excited states of the ^{133}La nucleus was confirmed by measuring the ratio of their quadrupolar moments. (France)

10939 EXCITED LEVELS OF ^{228}Th DEDUCED FROM THE OBSERVATION OF $\gamma-\gamma$ COINCIDENCES IN THE DECAY OF ^{228}Ac. Dalmasso, Josette; Maria, Henriette (Univ., Nice). Compt. Rend., Rend., Ser. B; 273: No. 13, 568-71(27 Sep 1971). (In French).

The $\gamma-\gamma$ coincidence measurements made with a ^{228}Ra source indicate the existence of new levels in ^{228}Th at 874.4, 1175.2, 1344.7, 1539.3, 1643.2, 1683.1, 1743.8, 1760.0 and 2010.1 keV. (France)

10940 MAGNETIC PARAMETERS FOR TRANSITIONS FROM THE FIRST EXCITED STATES IN ^{175}Lu, ^{167}Er and ^{173}Yb. Dar, Y.; Gerber, J.; Macher, A.; Vivien, J. P. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A171: No. 3, 575-83(1971).

The mean lives of the first excited states in ^{175}Lu, ^{167}Er and ^{173}Yb were measured using a modified version of the microwave method. The results obtained are: $\tau(^9/_2$, 114 keV, ^{175}Lu) = 137 ± 8ps, $\tau(^9/_2$, 79 keV; ^{167}Er) = 166 ± 13ps if $\delta^2 = 0.04$, = 172 ± 13ps if $\delta^2 = 0.10$, $\tau(^7/_2$, 79 keV, ^{173}Yb) = 75 ± 9ps. The deduced values of $|g_K - g_R|$ are found to agree with values obtained from branching ratio measurements of higher levels in these nuclei. The magnetic parameters are compared with recent theoretical results. (auth)

10941 LIFETIME OF THE 4.82 keV STATE IN ^{151}Sm. Drost, H.; Weiss, W.; Weyer, G. (Freie Univ., Berlin). Nucl. Phys.; A172: No. 2, 348-52(1971).

The half-life of the 4.82 keV state in ^{151}Sm was measured by γ-conversion electron delayed coincidence techniques. The result is $T_{1/2} = 35 \pm 1$ ns. (auth)

10942 EQUILIBRIUM QUADRUPOLE AND HEXADECAPOLE DEFORMATIONS IN ^{230}Th AND ^{238}U. McGowan, F. K.; Bemis, C. E.; Ford, J. L. C. Jr.; (and others) (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 27: No. 25, 1741-4(20 Dec 1971).

Large contributions to the excitation of 4^+ rotational states from E4 transitions were observed in precision Coulomb-excitation experiments with ^{4}He projectiles for even–even targets in the mass range $230 \leq A \leq 252$. The values of B(E4, $0 \rightarrow 4$) deduced from an analysis of the Coulomb-excitation probabilities for ^{230}Th and ^{238}U are $(1.10 \pm 0.44)e^2\,b^4$ and $(1.26 \pm 0.52)e^2\,b^4$, respectively. The deformation parameters β_{40} are 0.110 ± 0.027 and 0.100 ± 0.028 for ^{230}Th and ^{238}U, respectively. (auth)

10943 1971 ATOMIC MASS EVALUATION . PART I. ATOMIC MASS TABLE. Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Oak Ridge National Lab., Tenn.); Gove, N. B. Nucl. Data, Sect. A; 9: No. 4-5, 267-301(Jul 1971).

Atomic masses, based on a least-squares fit to the experimental data for all nuclides for which data are available and on estimates obtained from systematics for many other nuclides, are presented in a table together with several derived data. (auth)

10944 1971 ATOMIC MASS EVALUATION. PART II. NUCLEAR-REACTION AND SEPARATION ENERGIES. Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Oak Ridge National Lab., Tenn.); N. B. Gove. Nucl. Data, Sect. A; 9: No. 4-5, 303-55(Jul 1971).

Values are given for a number of separation energies of particles and particle groups and for ground state Q values of reactions in which the mass number changes by at most four units. The values, and their errors, for twelve of the simple linear combinations of nuclear masses involved were obtained in the least-squares fit of the empirical data yielding the 1971 table of atomic masses. (auth)

10945 1971 ATOMIC MASS EVALUATION. PART III. EVALUATION OF INPUT VALUES: ADJUSTMENT PROCEDURES. Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Oak Ridge National Lab., Tenn.); Gove, N. B. Nucl. Data, Sect. A; 9: No. 4-5, 357-455(Jul 1971).

This paper describes the philosophy and procedures used in selecting nuclear-reaction and decay data and mass-spectroscopic doublet measurements as input for the calculation of best values of relative atomic masses. Details of the least-squares methods used in the calculation are also given. Both accepted and rejected experimental data are presented in tables, are compared with the adjusted values, and are discussed when necessary. (auth)

10946 1971 ATOMIC MASS EVALUATION. PART IV. SYSTEMATICS OF SEPARATION AND DECAY ENERGIES. Gove, N. B. (Oak Ridge National Lab., Tenn.); Wapstra, A. H. Nucl. Data, Sect. A; 9: No. 4-5, 457-68(Jul 1971).

Figures are presented showing the separation energies of two neutrons as functions of N, of two protons as functions of Z, of alpha-decay energies as functions of N, and of beta-decay energies (odd-mass nuclides) as functions of A. The ranges covered are $9 < N < 158$, $9 < Z < 103$, $8 < N < 158$, $46 < A < 258$, respectively. (auth)

10947 LEVELS IN ^{186}Os POPULATED IN THE DECAY OF 15.8-h ^{186}Ir. Keenan III, Joseph Aloysius. Worcester, Mass.; Clark Univ. (1971). 200p. University Microfilms Order No. 71-23,138.

Thesis.

Energies and intensities of 180 γ rays emitted in the decay of 15.8-h ^{186}Ir have been determined with high-resolution Ge(Li) detectors. Iridium sources were prepared by the reactions ^{185}Re(^{4}He,3n)^{186}Ir and ^{185}Re(^{3}He,2n)^{186}Ir. Iridium was chemically separated from the target material after bombardment. Mass assignments for the γ rays which were observed were based upon their rates of decay and relative yields in ^{4}He and ^{3}He bombardments. The relative γ-ray intensities were normalized to conversion-electron intensities of previous workers such that transitions of known multipolarity had K-conversion coefficients in agreement with theory. Conversion coefficients and multipole assignments were derived for most of the transitions. The γ-ray energies, intensities, and multipolarities are consistent with the previously suggested rotational bands built upon the ground state and a γ vibration. No evidence has been discovered for the existence of a rotational band built upon a β vibration as predicted by theory. A partial level scheme is tentatively proposed on the basis of energy sums. Because of the large number of γ rays involved, coincidence measurements are essential to resolve ambiguities. Spins and parities consistent with the multipolarities of connecting transitions are suggested for all levels. (Diss. Abstr. Int., B)

10948 NUCLEAR SPECTROSCOPIC STUDY OF THE ANOMALOUS $5/2^+$, $1/2^+$, AND $9/2^+$ STATES IN THE ODD-MASS ISOTOPES OF Tc AND Rh. Phelps, Michael Edward. St. Louis; Washington Univ. (1971). 263p. University Microfilms Order No. 71-19,826.

Thesis.

The nuclear level structures of ^{99}Rh, ^{101}Rh, ^{103}Rh, ^{95}Tc, ^{97}Tc, ^{56}Fe, and ^{66}Zn have been investigated by studying the β- and γ-rays from the decay of 21-min ^{99}Pd, 8.5-h ^{101}Pd, 40-d ^{103}Ru, 1.7-h ^{95}Ru, 2.9-d ^{97}Ru, 77.3-d ^{56}Co and 9.5-h ^{66}Ga, respectively. Gamma-ray spectra, β-ray spectra, x-ray spectra, conversion-electron and $\gamma-\gamma$, $\gamma-\gamma-\gamma$, $\beta-\gamma$ coincidence spectra have been measured with Ge(Li), Si(Li) semiconductor detectors and NaI(Tl) and plastic scintillation detectors. The level structure of ^{101}Rh has also been studied via the ^{100}Ru(^{3}He,d) and ^{100}Ru(^{4}He,t) reactions using a tandem Van de Graaff and an Enge split-pole magnetic spectrograph. A decay scheme of ^{99}Pd has been constructed which consists of 33 excited levels in ^{99}Rh. Of the 126 γ-rays which were assigned to ^{99}Pd, 114 were placed in the scheme of which only 4 had been previously reported. The Q_{EC} has been measured from β^+-ray spectra and $\beta^-\text{-}\gamma$ coincidence spectra and found to be 3405 ± 20 keV. The fraction of decay of ^{99}Pd to the 16-d ^{99}Rh ground state has been measured from milking experiments and also from the proposed decay scheme. The K-shell conversion coefficient and the K/L + M ratio of the 136.0- and 263.6-keV transitions have been measured and E2/M1 mixing ratios deduced. Limits for the J^π values of 25 levels in ^{99}Rh have been assigned from log ft values, transition multipolarities, and γ-ray branching information. A total of 18 excited levels in ^{101}Rh have been established from the decay of ^{101}Pd. Of the 51 γ-rays assigned to ^{101}Pd, of which only 15 had been previously reported, 59 were placed in the decay scheme. The K-shell and total conversion coefficients and the K/L + M ratios have been determined for the most intense transitions in ^{101}Rh and E2/M1 mixing ratios deduced. The K-shell conversion coefficient, the K/L + M ratio and the fraction of decay of the 4.5-d isomeric transition in ^{101}Rh were also measured. From log ft values, transition multipolarities and γ-ray intensity information definite J^π assignments were made to 9 levels and limits for the J^π values were placed for 9 of the remaining levels in ^{101}Rh. The level structure of ^{101}Rh has been further investigated via the ^{100}Ru(^{3}He,d) and ^{100}Ru(^{4}He,t) single-proton transfer reactions. An additional six levels in ^{101}Rh below 2200 not observed in the ^{101}Pd decay are reported. The single-particle and the collective character of the low-lying states from their relative population in the above reactions is discussed. The K-shell conversion coefficient of the 53-keV transition ($7/2^+ \rightarrow 9/2^+$) in ^{103}Rh has been measured and the E2/M1 mixing ratio was determined. A decay scheme of ^{97}Ru was constructed which consisted of 9 excited levels. All of the 16 γ-rays which were assigned to ^{97}Ru were placed in the scheme. Only 9 γ-rays had been previously reported. The K-shell conversion coefficients were measured for 8 of the transitions in ^{97}Tc and a value for the E2/M1 mixing ratio was deduced for the 216-keV transition ($1/2^+ \rightarrow 9/2^+$). From log ft values, multipolarities from K-shell conversion coefficients and γ-ray intensity information definite J^π assignments were made to 6 levels and limits for the J^π values were placed for the 3 remaining levels. The K-shell conversion coefficient of the 336-keV transition ($7/2^+ \rightarrow 9/2^+$) in ^{95}Rc has been measured and the E2/M1 mixing ratio deduced. The level trends and E2/M1 mixing ratios of transitions in the odd-mass isotopes of ^{99}Rh through ^{105}Rh are examined in order to determine the effect of the addition of neutron pairs on similar states in these nuclides. The level trends and E2/M1 mixing ratios for transitions in the odd-mass Tc isotopes are also examined for similar states in the odd-mass Rh and Ag isotopes in order to determine the effect of adding proton pairs. Particular attention is given to the low-lying $9/2^+$, $1/2^+$ and $5/2^+$ states. The level structures of ^{99}Rh, ^{101}Rh and ^{97}Tc have also been compared to the predictions of recent models for the nucleus based on the quasiparticle-phonon-coupling scheme. The decay schemes of ^{56}Co and ^{66}Ga were investigated in an effort to obtain good energy and intensity standard γ-ray sources. The energies and intensities of the γ-ray transitions in ^{56}Fe and ^{66}Zn have been carefully measured with a Ge(Li) detector in conjunction with a large split annular NaI(Tl) detector operated as an anti-Compton or a pair-three-crystal coincidence spectrometer. Three new transitions were assigned to the decay scheme of ^{56}Co and 21 new γ-transitions were assigned to the decay of ^{66}Ga. From log ft values and from γ-ray intensity information J^π values to many levels in ^{66}Zn were deduced. (Diss. Abstr. Int., B)

10949 INTERMEDIATE COUPLING CALCULATIONS ON THE ODD-MASS ISOTOPES OF INDIUM. Atalay, Bulent Ismail. Washington, D. C.; Georgetown Univ. (1971). 192p. University Microfilms Order No. 71-23,408.

Thesis.

The Unified Model in Intermediate Coupling has been applied to the odd-mass isotopes of Indium $^{109-117}$In. Using three free parameters, the dimensionless interaction parameter ξ, the effective 2+ phonon of the core $\hbar\omega$, and the single-particle energy separations Δ_j, theoretical energy spectra were fitted to the experimental. The wavefunctions obtained during the diagonalization of the Hamiltonian were used in calculating magnetic dipole moments for the ground and first excited states, the quadrupole moments of the ground states, and M1 and E2 reduced transition probabilities for transitions between the second and first excited states. In reproducing the observed values of the magnetic dipole and electric quadrupole moments effective values of the spin g-factor and interaction strength parameter were employed. These were found to vary remarkably smoothly with the mass number A. The following values for the hitherto unmeasured properties of the Indium isotopes are predicted: magnetic moment of the ground state of ^{117}In: 5.516 n.m.; the quadrupole moment of the ground state of ^{117}In: 1.057 (10^{-24} cm^2); the B(M1) and B(E2) values for ^{113}In for the decay of the second excited state to the first excited: 0.7082 e^2(10^{-24} cm^2) and 0.1494 e^2(10^{-24} cm^2)^2, respectively. The results obtained in the present work are compared with those obtained by other investigators using other models. (Diss. Abstr. Int., B)

10950 LEVEL SCHEME OF ^{173}Lu FROM DECAY OF ^{173}Hf. Kishore, Raj. Worcester, Mass.; Clark Univ. (1971). 123p. University Microfilms Order No. 71-24,738.

Thesis.

The level scheme of ^{173}Lu was studied by measuring the gamma-rays emitted following electron-capture decay of ^{173}Hf. Gamma-ray energies and intensities were measured using high-resolution Ge(Li) detectors. Generic relationships of the intense gamma-rays were established by Ge(Li)–Ge(Li) coincidence measurements. Multipolarities of the gamma-rays of energies ≤800 keV were determined by combining measurements of the conversion electron spectra made with a Si(Li) detector with the gamma-ray data. Based on the above measurements a level scheme of ^{173}Lu was constructed. Log ft values were calculated using Moszkowski nomographs. Spin and parity assignments were made when possible. The $3/2^-$[532], $3/2^+$[411] and $1/2^-$[530] Nilsson levels were identified in the level scheme for the first time. A possible case of $\Delta N = 2$ mixing for proton orbitals ($1/2^+$[660] and $1/2^+$[400]) is proposed. (Diss. Abstr. Int., B)

10951 STUDY OF THE TWO PARTICLE-ONE HOLE STATES IN ^{209}Pb BY MEANS OF THE (d,p) REACTION. Kovar, Dennis Gene. New Haven; Yale Univ. (1971). 312p. University Microfilms Order No. 71-22,353.

Thesis.

The ^{208}Pb(d,p)^{209}Pb reaction was studied at a deuteron energy of 20.0 MeV. The purpose was to determine the extent to which two particle-one hole (2p-1h) states in ^{209}Pb could be excited by this reaction; and then to use this information to study the shell closure of the ^{208}Pb ground state and the fragmentation of the single-particle strength in ^{209}Pb. In addition to the strong transitions to the single-particle states, there were observed over 35 weak transitions of cross section 10–100 μb/sr. leading to states of 2p-1h character in the excitation region 2.0 to 4.5 MeV in ^{209}Pb. These transitions had angular distributions which exhibited typical stripping patterns and were assumed to occur by a direct neutron transfer mechanism. They were assigned l-values and spectroscopic factors by a DWBA analysis of the angular distributions. The qualitative agreement between the model calculations and the experimental results supports the interpretation of these transitions as one-step neutron transfers proceeding in some cases via single-particle admixtures in the final states and in most cases (at least for the transitions to states up to 4.0 MeV excitation) via correlations in the ^{208}Pb ground state. While the measured 2p-2h admixtures in the ^{208}Pb ground state were found to have individual amplitudes squared of the order about 1%, the good agreement of the predictions of the RPA calculations with our results implies that the RPA description of the ^{208}Pb ground state is essentially correct insofar as comparison is possible and hence the ^{208}Pb ground state departs from a pure doubly closed shell configuration. No evidence for fragments of positive parity single particle states of the N = 126–184 shell is found below 4.0 MeV. The major fraction (60%) of the negative parity $1j_{15/2}$ state resides in the well known level at 1.42 MeV, but additional fragments are now found between 3.0 and 4.0 MeV excitation. There is also evidence that strength from the N > 184 shell is found below 4.0 MeV. The results provide additional evidence that 2p-1h states in ^{209}Pb are qualitatively well described in terms of a hole coupled to the two-particle

excitations of ^{210}Pb or a particle coupled to the core excitations of ^{208}Pb, although the details of the structure such as the configuration mixing are not yet reproduced by present particle-core calculations. (Diss. Abstr. Int., B)

10952 RADIATIVE CAPTURE CROSS SECTIONS OF ^{69}Ga, ^{71}Ga, ^{139}La, AND ^{141}Pr FOR FAST NEUTRONS. Zaikin, G. G.; Korzh, I. A.; Pasechnik, M. V.; Sklyar, N. T. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1205-8(Jul 1971). (In Russian).

The radiative capture cross sections of ^{69}Ga, ^{71}Ga, ^{139}La, and ^{141}Pr were measured for neutrons possessing energies in the range 0.2 to 3.1 MeV by use of activation analysis; in addition, the last three isotopes were studied for neutron energies in the range 5.90 ± 0.28 MeV. The neutrons were obtained from the reactions ^{7}Li(p,n)^{7}Be, T(p,n)^{3}He, and D(d,n)^{3}He. The energy dependence of the capture cross section was determined relative to the fission cross section of ^{235}U. Absolute normalization of the cross section was obtained by comparing the activities obtained by using fast neutrons and thermal neutrons. The results are compared with cross sections calculated from the statistical model. (tr-auth)

10953 RADIATSIONNYI ZAKHVAT BYSTRYKH NEITRONOV. (Radiative Capture of Fast Neutrons). Stavisskii, Yu. Ya.; Abramov, A. I.; Van'kov, A. A.; (and others). Moscow; Atomizdat (1970). 284p.

A survey is made of the effective cross sections for radiative capture of neutrons with energies of from 1 keV to 20 MeV. Methods of measuring capture cross sections discussed include transmission in spherical geometry, recording capture gamma rays, and activation; their sensitivity and precision are evaluated. The work is primarily an atlas of effective cross sections from Mg to Pu, taken from publications between 1950 and 1967. The problem of theoretical calculation of capture cross sections from nuclear theory and optical models is discussed. (142 references). (tr-auth)

10954 MASS SPECTROMETRIC DETERMINATION OF NEUTRON CAPTURE CROSS SECTIONS OF RARE EARTH ISOTOPES. Dobrozemsky, R.; Pichlmayer, F.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). J. Mass Spectrom. Ion Phys.; 6: No. 5-6, 435-50(Jun 1971). (In German).

For the determination of neutron capture cross sections of rare earth isotopes, the corresponding elements were electromagnetically separated and the highly enriched isotopes were irradiated with and without Cd shielding in the ASTRA reactor to an integrated neutron flux of about 10^{20} n cm^{-2}. Before and after irradiation the isotopic abundances were measured by mass spectrometry. The pile capture cross section, the thermal capture cross section, and the effective resonance integral for ^{147}Sm, ^{148}Sm, ^{154}Gd, ^{156}Gd, ^{160}Dy, ^{161}Dy, ^{162}Dy, ^{163}Dy, ^{166}Er, ^{170}Yb, ^{171}Yb, ^{172}Yb, and ^{173}Yb were obtained; the results are given in the text. (auth)

10955 LOW-ENERGY GAMMA-RAY SPECTRUM OF ^{184m}Re. Taylor, H. W.; King, J. D.; Singh, B. (Univ. of Toronto). Can. J. Phys.; 49: No. 20, 2614-18(15 Oct 1971).

The gamma rays emitted by ^{184m,184}Re with energies below 300 keV were studied with a Si detector and a 4096-channel analyzer. The energies of several high-lying levels in ^{184}W were adjusted through the proper positioning of these gamma rays in the ^{184}W level scheme. (auth) (Canada)

10956 LOW-LYING 0^+ STATES AND (p,t) STRENGTHS IN THE ACTINIDES. van Rij, W. I.; Kahana, S. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 28: No. 1, 50-4 (3 Jan 1972).

A noncollective description of the low-lying 0^+ states strongly excited in (p,t) reactions in the actinides is presented. The description is based on the possible weakness of the oblate–prolate pairing force, suggested by Griffin, Jackson, and Volkov [Phys. Lett., 36B: 281(1971)], and the low density of oblate states near the Fermi surface in these nuclei. (auth)

10957 QUADRUPOLE MOMENT OF THE 660-keV ROTATIONAL LEVEL OF ^{117}In. Raghavan, R. S.; Raghavan, P. (Technische Univ., Munich). Phys. Rev. Lett.; 28: No. 1, 54-7(3 Jan 1972).

The quadrupole interaction frequency $\nu_Q = e^2qQ/h$ of the 660-keV ($I = 9/2^+$) level of ^{117}In was measured by the method of time-differential perturbed angular correlations in an alloy of $In_{0.99}Cd_{0.01}$ at 4.2°K. From the known quadrupole interaction of ^{115}In in the same alloy at 4.2°K and the atomic beam value of Q(^{115}In), the quadrupole moment of this level is deduced to be $|Q| = 0.64(4)$ b, in remarkable agreement with the theoretical value of 0.636 b derived from a description of this level as a rotational state of a $K = 1/2^+$ band. (auth)

10958 OBSERVATION OF T = 23 DOUBLE ANALOG STATES IN ^{210}Po. Hoffmann, G. W.; Ogo, G. J.; Whitten, C. A. Jr.; Dunlop, W. H.; Kulleck, J. G. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 28: No. 1, 41-4(3 Jan 1972).

The T = 23 states in $^{210}_{84}Po_{126}$ ($T_3 = 21$) that are the isobaric analogs of the $T = T_3 = 23$ ground state and low-lying states in $^{210}_{82}Pb_{128}$ were observed as enhancements in the excitation function for the reaction $p + {}^{209}_{83}Bi_{126} \rightarrow {}^{209}_{82}Pb_{126} + 2p$. The experimentally observed enhancements in the two-proton coincidence excitation function correlate with the known level structure of ^{210}Pb and occur at the incident proton energies predicted by Coulomb energy formulas; this result establishes that these enhancements are due to the population of double analog levels in ^{210}Po. (auth)

10959 INVESTIGATION OF THE GAMMA-RAY SPECTRUM AND TRANSITION INTENSITIES IN THE DECAY OF ^{182}Ta. Mladenovic, M.; Ninkovic, M.; Stojanovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Fizika (Zagreb); 3: No. 4, 219-38(Oct 1971).

The photon spectrum from the decay of ^{182}Ta was measured with a 14 cm^3 Ge(Li) detector of a resolution of 3.5 keV at the ^{60}Co energies. Using the relative intensities of gamma-ray lines determined from the spectrum, and the published data on the internal conversion spectrum, the total transition intensities were computed and the balance of intensities in the decay scheme was made. A discussion of the present knowledge of the decay scheme of ^{182}W is given. (auth)

10960 EXCITED LEVELS OF ^{134}Ba FROM THE DECAY OF ^{134}La. Reuland, D. J. (Indiana State Univ., Terre Haute). Nucl. Phys.; A176: No. 3, 657-64(1971).

Energy levels of ^{134}Ba populated in the decay of ^{134}La have been studied with a large-volume high-resolution Ge(Li) spectrometer system. Several unreported γ-transitions were observed. Based on these transitions, a NaI(Tl)–Ge(Li) γ–γ coincidence study and the previously reported work on this system, a level scheme of ^{134}Ba is proposed. (auth)

10961 NUCLEAR PHOTOACTIVATION OF ^{115}In. Boivin, M.; Cauchois, Y.; Heno, Y. (Univ., Paris). Nucl. Phys.; A176: No. 3, 626-30(1971). (In French).

The photoactivation of ^{115}In showed 9 nuclear levels at 600, 830, 932, 943, 1078, 1465, 1495, 1565 and 1635 keV. Cross sections were calculated and characteristics proposed or confirmed for these levels. The results obtained, along with data derived from experiments performed elsewhere by other methods, were used to determine some partial widths and mean lives of several levels. (auth)

10962 ROTATIONAL STATES AND ROTATION-PARTICLE COUPLING IN ^{155}Tb AND ^{157}Tb. Winter, G.; Funke, L.; Kaun, K.-H.; Kemnitz, P.; Sodan, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A176: No. 3, 609-25(1971).

For the investigation of excited states of the odd-proton nuclei ^{155}Tb and ^{157}Tb, studies have been made of the γ-radiation emitted in the reactions ^{153}Eu(α,2n), ^{155}Gd(d,2n) and ^{155}Gd(p,n) as well as ^{157}Gd(d,2n) and ^{157}Gd(p,n), respectively. Measurements of coincidence relations were performed in the reactions with α-particles and deuterons. Furthermore, in the reaction with α-particles excitation functions and angular distributions of γ-rays were measured. The level schemes proposed for ^{155}Tb and ^{157}Tb are very similar. They contain the band heads (energies are given in keV for ^{155}Tb and ^{157}Tb, respectively) $3/2^+$[411] (ground state), $5/2^+$[413] (271.3; 327.6), $7/2^+$[404] (466.9; 658.6), $5/2^-$[532] (227.0; 326.4) and $7/2^-$[523] (545.3; 571.7), as well as several rotational states. In both nuclei the distorted rotational band built on the $5/2^-$[532] band head has been analyzed in terms of the Coriolis coupling between the Nilsson orbitals based on the $h_{11/2}$ shell-model state. In ^{155}Tb the Coriolis coupling (mainly with the $7/2^+$[404] orbital) gives rise to an energy difference of only 63.7 keV between the $7/2$ and $5/2$ members of the $5/2^+$[413] band. (auth)

10963 EXTENDED SHELL-MODEL CALCULATIONS OF THE LEAD ISOTOPES WITH A < 208. Harvey, Ted F. (Univ. of California, Davis); Clement, David M. Nucl. Phys.; A176: No. 3, 592-608(1971).

A number of model calculations of the lead isotopes with A < 208 are performed using as an effective interaction the bare Tabakin reaction matrix plus a pairing term to simulate core polarization: (1) standard shell-model calculations of ^{206}Pb and ^{205}Pb where the model space includes the six filling neutron orbitals below N = 126; (2) quasiparticle configuration-mixing calculations where the excited states of the even isotopes are treated in a two-quasiparticle basis, the odd isotopes in a one-quasiparticle, three-quasiparticle basis. The input to the latter calculations are the quasiparticle en-

ergies obtained from the (i) conventional BCS, (ii) the IGE and (iii) the improved IGE procedures. Spectroscopic factors for one-nucleon-transfer reactions are reported. It is concluded that the IGE model is particularly applicable in the lead region. (auth)

10964 SPECTRA OF HIGH-ENERGY PHOTONS FOLLOWING THE CAPTURE OF 14 MeV NEUTRONS BY ^{133}Cs, ^{139}La, Ce, AND ^{159}Tb. Rigaud, F. (CEN de Bordeaux, Gradignan, France); Irigaray, J. L.; Petit, G. Y.; Longo, G.; Saporetti, F. Nucl. Phys.; A176: No. 3, 545-52(1971).

Spectra of high-energy photons from the radiative capture of 14.06 MeV neutrons in ^{133}Cs, ^{139}La, Ce and ^{159}Tb are recorded by means of a time-of-flight spectrometer. The (n,γ) cross sections, deduced from the integration of measured spectra, are very close for the four nuclei considered. The value of the ^{159}Tb(n,γ) cross section obtained from the γ-ray spectrum is much lower than those previously measured from the activation of nuclei having approximately the same mass, such as ^{160}Gd, ^{164}Dy and ^{165}Ho. The difference between these two kinds of experimental results disappears for nuclei with closed neutron shells, such as ^{139}La. The direct and collective processes describe satisfactorily the present experimental data. (auth)

10965 LEVELS IN ^{128}Te. McDonald, John (Swedish Research Councils' Lab., Studsvik); Malmskog, Sven G. Nucl. Phys.; A176: No. 3, 526-34(1971).

The half-life of the 6^+ level at 1811 keV in ^{128}Te has been studied by the $\beta-\gamma$ delayed coincidence method using a mass separated source of ^{128}Sb ($T_{1/2}$ = 11 min) in equilibrium with ^{128}Sn ($T_{1/2}$ = 59 min). A discrepancy between the results obtained by two different methods of measurement led to the postulate that there was no significant direct β-feeding to the 4^+ level at 1497 keV in ^{128}Te from 11 min ^{128}Sb, and this was confirmed by a study of the chemically separated antimony activity using a Ge(Li) detector. A revised level scheme was constructed for ^{128}Te incorporating four new states above 2.4 MeV, and a consistent value of 0.42 ± 0.03 ns was deduced from the half-life of the 1811 keV level. This implies a B(E2) of 0.05 $e^2 \cdot b^2$ for the 314 keV transition which is therefore enhanced by a factor of 13 with respect to the Weisskopf estimate. This result is related to theoretical work, in particular to that dealing with ground state quasirotational bands. It is shown that the properties of neutron-rich tellurium nuclei are of special interest for an understanding of recent predictions based on the variable-moment-of-inertia model. (auth)

10966 MEASUREMENT OF THE MAGNETIC MOMENT AND LIFETIME OF THE $13/2^+$ LEVEL IN ^{205}Pb. Maier, K. H.; Leigh, J. R.; Diamond, R. M. (Univ. of California, Berkeley). Nucl. Phys.; A176: No. 3, 497-504(1971).

The g-factor, half-life, and branching ratios of the $13/2^+$, 1014 keV isomer in ^{205}Pb have been measured using pulsed-beam excitation through the ^{204}Hg(α,3n)^{205}Pb reaction (g = −0.150 ± 0.006, $T_{1/2}$ = 5.55 ± 0.2 ms). It is shown that this is the g-factor of the $i_{13/2}$ neutron orbit within 10%. (auth)

10967 ^{117,119}Sn(p,n)^{117,119}Sb REACTIONS NEAR 0^+ ANALOGUE STATES. Kernell, R. L.; Kim, H. J.; Robinson, R. L.; Johnson, C. H. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A176: No. 3, 449-65(1971).

Differential cross sections were measured for the ^{117,119}Sn(p,n)^{117,119}Sb reactions in the vicinity ($E_p \approx 4.5$ MeV) of 0^+ analog states in the compound nuclei ^{118,120}Sb. Three techniques have been used to establish spin-parities of the states in ^{117,119}Sb: (i) the amount of on resonant enhancement for the neutron groups, (ii) the differential cross sections off resonance and (iii) the relative yields off resonance. Energies (in keV) and I^π assignments for levels in ^{117}Sb are 1085 ($I \geq 7/2$), 1165 ($I \geq 7/2$), 1300 ($I \geq 7/2$) and 1355 ($1/2^-$). Those for ^{119}Sb are 644 ($1/2^+$), 700 ($3/2^+$), 975 ($3/2^-$, $I \geq 1/2$), 1337 ($1/2^-$), 1416 ($3/2^-$), 1547 ($5/2^-$, $I \geq 7/2$), 1665 doublet ($1/2^+$ and $1/2^+$, $5/2^+$), 1745 ($3/2^+$), 1822 ($1/2^+$), 1880 doublet ($3/2^+$ and $5/2^-$, $I \geq 7/2$), 1970 ($3/2^-$, $I \geq 7/2$) and 2130 doublet (1/2 for one). It is suggested that the observed $1/2^-$ and $3/2^-$ states are due to coupling of $d_{3/2}$ and $g_{7/2}$ single particles to the 3^- core state. The ground state Q-values were found to be −2.525 ± 0.020 MeV for the ^{117}Sn(p,n) reaction and −1.369 ± 0.015 MeV for ^{119}Sn(p,n). (auth)

10968 TWO-QUASIPARTICLE STATES IN $^{122\ 124\ 126}$Te. THE LEVEL SYSTEMATICS IN DOUBLY EVEN TELLURIUM NUCLEI. Kerek, A. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A176: No. 3, 466-80(1971).

Levels of even Te isotopes (A = 122 − 126) have been studied in Sn(α,2n) reactions. From intensity, angular distributions and excitation function measurements, members of the even-parity band up to 10^+ are assigned. The negative-parity states 5^- and 7^- interpreted to have configurations ($h_{11/2}$, $s_{1/2}$) and ($h_{11/2}$, $d_{3/2}$) are also observed. The assignments in ^{124}Te are supported by $\gamma-\gamma$ coincidence measurement. The level structure of high-spin states in doubly even Te (A = 114 − 134) is discussed. (auth)

10969 FISSION TEMPERATURES AS A FUNCTION OF THE AVERAGE NUMBER OF NEUTRONS FROM FISSION. Howerton, R. J.; Doyas, R. J. (Univ. of California, Livermore). Nucl. Sci. Eng.; 46: No. 3, 414-16(Dec 1971).

Terrell [Phys. Rev., 113: 527(1959)] proposed a relationship between the mean energy of a fission spectrum and the average number of neutrons resulting from fission. By using the relationship between the mean energy of fission neutrons and the Maxwellian temperature of the fission spectrum, his relationship can be written as $T_m = a + b\,(1 + \bar{\nu}_f)^{1/2}$, where $\bar{\nu}_f$ is the average number of neutrons from the fission process excluding any prefission neutrons from the (n,n'f) and (n,2nf) modes of fission. A weighted least-squares method was used to obtain values for a and b from available experimental determinations of T_m or its equivalent. The values obtained are a = 0.353, b = 0.510. A fit of the relationship $T_m = c + d\bar{\nu}_f$ yielded values for c and d of 0.997 and 0.125, respectively. The goodness-of-fit criteria are essentially the same for the two representations. Terrell's relationship was derived from theoretical considerations, but there is no theoretical basis for the linear representation. (auth)

10970 FAST NEUTRON TOTAL AND SCATTERING CROSS SECTIONS OF ^{238}U. Lambropoulos, P. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 46: No. 3, 356-65(Dec 1971).

Neutron total and scattering cross sections of ^{238}U are interpreted in terms of a local, energy-dependent spherical optical potential with spin−orbit coupling. Total cross sections to 10.0 MeV and scattering cross sections to 1.5 MeV, at 2.0 MeV, and 7.0 Mev were calculated and compared with reported experimental results and with values measured explicitly for support of these calculations. The statistical model was used in calculating elastic and inelastic scattering processes, and capture and fission reactions were taken into account. The effects of resonance width fluctuations and correlations and of deformation were examined. Satisfactory agreement was achieved between calculation and experiment. (auth)

10971 DETERMINATION OF THE ENERGY OF THE MOST INTENSE α PARTICLES FROM ^{229}Th AND SEVERAL ISOTOPES OF Cm, Bk, AND Cf. Baranov, S. A.; Shatinskii, V. M.; Kulakov, V. M. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 5, 1101-2(Nov 1971). (In Russian).

The energies of the most intense alpha particles were determined for the following isotopes: ^{229}Th, ^{240}Cm, ^{241}Cm, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{249}Bk, ^{249}Cf, ^{250}Cf, ^{251}Cf, ^{252}Cf, ^{253}Es, ^{254}Es, ^{255}Es, and ^{256}Fm. (L.T.W.)

10972 ANGULAR ANISOTROPY AT FISSION OF ^{226}Ra INDUCED BY NEUTRONS WITH ENERGIES OF 4 TO 10 MeV. Ippolitov, V. T.; Nemilov, Yu. A.; Selitskii, Yu. A.; Funshtein, V. B. Yadern. Fiz.; 14: No. 5, 939-42(Nov 1971). (In Russian).

On the basis of the measured angular distribution of fragments from neutron-induced fission of Ra in the present and previous works, the dispersions are calculated for distributions of the total angular momentum projection on the symmetry axis of the nucleus in the saddle point. Analyzing the value and the energy dependence one concludes that the energy-gap parameter increases in the saddle point of ^{227}Ra up to the value $2\Delta_f = 2.7 \pm 0.7$ MeV. An attempt is made to explain this effect by an essential increase of the nuclear surface area in the saddle point for relatively light fissile nuclei. (auth)

10973 MASS DISTRIBUTION OF THE FISSION PRODUCTS FROM ^{249}Cf EXPOSED TO SLOW NEUTRONS. Kurchatov, B. V.; Morozov, L. N.; Novgorodtseva, V. I.; (and others) (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 5, 943-9 (Nov 1971). (In Russian).

Yields of 35 isotopes produced in the fission of ^{249}Cf induced by slow neutrons are determined by the radiochemical method. The mass distribution is asymmetrical with maxima at the mass values of 106 and 139.5. The dip-peak ratio equals (or is something lower than) 1/50. The value of $\bar{\nu}$ = 4.0 ± 0.5 is obtained from the yield curve. (auth)

10974 RELATIVE YIELDS OF XENON ISOTOPES AT PHOTOFISSION OF ^{238}U. Petrzhak, K. A.; Teplykh, V. F.; Pan'yan, M. G.; Demin, V. A. (Leningrad Technological Inst. of the Refrigeration Industry). Yadern. Fiz.; 14: No. 5, 950-2 (Nov 1971). (In Russian).

Relative yields of the isotopes ^{131}Xe, ^{132}Xe, ^{134}Xe, and ^{136}Xe are measured for the photofission of ^{238}U at maximum bremsstrahlung energies of 15 and 25 MeV. A highly sensitive mass spectrometer was used. The fine-structure peak of the fragment

yield curve is established to be at A = 134 for both the energies. The results of the measurements are compared with the experimental data by other authors obtained for spontaneous fission of the same nucleus. (auth)

10975 LEVELS IN ^{174}Hf FROM ^{174}Ta DECAY AND beta-BAND MIXING. Bowman, W. W.; Sugihara, T. T. (Texas A and M Univ., College Station). Nucl. Phys.; A178: No. 1, 263-74(1971).

The energy levels of ^{174}Hf that are populated in the decay of 1.2-h ^{174}Ta were investigated with Ge(Li) γ-ray spectrometers in singles and coincidence modes. The ground-state rotational band, which is populated to the 6^+ member, is strongly fed by β decay. Energies (in keV) of levels that were deduced from coincidence spectra are for the ground-state rotational band 2^+, 90.9; 4^+, 297.4; and 6^+, 608.1; for a β-vibrational band 2^+, 900.4 and 4^+, 1062.5; and an additional level at 1503.4. From energy sums and differences, other levels are tentatively proposed at 1226.9, 1394.4, and 1450.2 keV. Relative intensities of the transitions depopulating each β-band level to three members of the ground state band were determined. From the intensities of the ΔI = ±2 transitions from the levels I_β = 2 and 4, the value of the band-mixing parameter z_0 is found to be 0.0224 ± 0.0007, consistent with the expectations of the first-order theory for nonadiabatic coupling of rotational and intrinsic motions. The M1 fractions required to fit the observed ΔI = 0 transition intensities are (20.7 ± 3.8)% for I_β = 2 and (48.2 ± 3.0)% for I_β = 4. (auth)

10976 MUON CAPTURE IN ^{151}Eu AND ^{153}Eu. Petitjean, C.; Backe, H.; Engfer, R.; (and others) (CERN, Geneva). Nucl. Phys.; A178: No. 1, 193-200(1971).

Delayed γ rays from μ capture in natural europium were measured with a Ge(Li) detector. From absolute γ intensities, populations of individual final levels were deduced. In (81 ± 12)% of the μ-capture process, an excited final nucleus was detected. The distribution of excited nuclei is compatible with the neutron multiplicity distribution calculated by Singer [Nuovo Cim., 23: 669(1962)]; however, the predicted zero neutron emission was not found. From the analysis of the time distribution of the γ intensities an isotopic effect for the capture rates was found to be $[\lambda_c(^{151}\text{Eu}) - \lambda_c(^{153}\text{Eu})]/\overline{\lambda_c}$ = (8.4 ± 2.7)%, which agrees with predictions from Primakoff's μ-capture formula [Rev. Mod. Phys., 31: 802 (1959)]. (auth)

10977 ISOMERISM IN THE DECAY OF ^{154}Pm TO THE LEVELS OF ^{154}Sm. D'Auria, J. M.; Ostrom, D.; Gujrathi, S. C. (Simon Fraser Univ., Burnaby, British Columbia). Nucl. Phys.; A178: No. 1, 172-92(1971).

A spectroscopic study of the decay of ^{154}Pm to the levels of ^{154}Sm was performed using Ge(Li) and scintillation spectrometers. The radioactive sources were produced from the (n,p) reaction by bombarding isotopically enriched (99.54%) samarium targets with 14.8-MeV neutrons. Long-lived isomerism was observed in the levels of ^{154}Pm. The half-lives of the two isomeric levels are 1.8 ± 0.2 and 2.8 ± 0.2 min with an energy separation of ≲200 keV in 3.9 ± 0.2 MeV. On the basis of the half-life measurements of several γ-ray photopeaks as well as the results of β, γ, γ−γ and β−γ spectroscopic measurements, consistent decay schemes of each β-unstable level are proposed for the first time; over 60 γ rays feeding 26 levels in ^{154}Sm up to 2372 keV are included. The [IπK] spin configurations for the ^{154}Pm isomers are tentatively assigned as [3 ± 3] ($T_{½}$ = 2.8 min) and [0 ± 0] ($T_{½}$ = 1.8 min). The results are discussed in terms of the unified model and the two-quasi-particle model, and it is further suggested that the levels at 2069.4 and 2140.5 keV could correspond to two-proton quasi-particle states. (auth)

10978 DECAY OF 8 min ^{102m}Ag AND 13 min ^{102g}Ag. Hnatowich, D. J.; Muennich, F.; Kjelberg, A. (CERN, Geneva). Nucl. Phys.; A178: No. 1, 111-22(1971).

The decay of 8-min and 13-min ^{102}Ag was investigated using isotopically separated samples produced by the ISOLDE facility. Partial decay schemes for the two isomers of ^{102}Ag are proposed. The percentage of isomeric transition in this nuclide was determined to be (49 ± 5)%. (auth)

10979 DECAY OF 33 min ^{104m}Ag AND 69 min ^{104g}Ag. Muennich, F.; Kjelberg, A.; Hnatowich, D. J. (CERN, Geneva). Nucl. Phys.; A178: No. 1, 97-110(1971).

The decay of 33-min and 69-min ^{104}Ag was investigated using isotopically separated samples produced by the ISOLDE facility at CERN. A total of 25 excited levels in ^{104}Pd were found. The percentage isomeric transition in ^{104}Ag was determined to be 33 ± 5%. (auth)

10980 ENERGIES AND INTENSITIES OF CURIUM L X-RAYS EMITTED IN COINCIDENCE WITH THE alpha-DECAY OF ^{252}Cf. Watson, R. L.; Li, T. K. (Texas A and M Univ., College Station). Nucl. Phys.; A178: No. 1, 201-13(1971).

The energies and intensities of curium L x rays associated with the α decay of ^{252}Cf were measured with a high-resolution Si(Li) spectrometer. The measured total intensity of L x rays was $(7.83 \pm 0.40) \times 10^{-2}$ per α decay. In addition, the γ ray from the first excited state in ^{248}Cm was observed. The energy of this γ ray was determined to be 43.399 ± 0.025 keV, and its intensity was $(1.53 \pm 0.09) \times 10^{-4}$ per α decay. From the γ ray intensity and the α-branching ratio to the first excited state, the total conversion coefficient for this transition was found to be 1013 ± 70. By using the L x-ray and γ-ray intensities, the L_{II} and L_{III} subshell fluorescence yields were derived. The values obtained are ω_{LII} = 0.59 ± 0.04 and ω_{LIII} = 0.68 ± 0.05. As part of the calibration procedure, a detailed examination of the intensities of Np L x rays associated with the α decay of ^{241}Am was carried out. Results of this analysis are compared with previously reported intensities that had been renormalized to correct approximately for large absorption effects. (auth)

10981 YIELDS AND KINETIC ENERGIES OF FRAGMENTS AT THE FISSION OF ^{233}U AND ^{239}Pu BY 5.5 AND 15 MeV NEUTRONS. Surin, V. M.; Sergachev, A. I.; Rezchikov, N. I.; Kuz'minov, B. D. (Inst. of Physical Energy, Moscow). Yadern. Fiz.; 14: No. 5, 935-8(Nov 1971). (In Russian).

Measurements were made of the fragment distributions in masses and kinetic energies in the fission of ^{233}U and ^{239}Pu by 5.5 and 15 MeV neutrons. The increase of symmetrical fragment yields and the decrease of the mean kinetic energy of fragments are noted. The variations of kinetic energies of fragments with different masses are different both in the absolute value and in the sign. (auth)

10982 RELATIVE MEASUREMENTS OF ν IN FISSION OF ^{235}U AND ^{239}Pu BY RESONANCE NEUTRONS. Ryabov, Yu. V.; So Don, Sik; Chikov, N.; Yaneva, N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 5, 927-34(Nov 1971). (In Russian).

Spin independence is detected in the yield of average number of prompt neutrons per fission for ^{235}U and ^{239}Pu in the neutron energy regions 1 to 40 eV and 5 to 85 eV, respectively. (auth)

10983 STUDY OF ^{172}Tm. Barat, J. L. (Institut des Sciences Nucleaires, Grenoble, France); Benabed, A.; Treherne, J. Nucl. Phys.; A178: No. 2, 625-39(1972).

This study of the odd nucleus ^{172}Tm, obtained from the β decay of ^{172}Er, has been performed by means of two iron-free double-focussing spectrometers, Ge(Li) detectors and coincidence techniques. The proposed level scheme is consistent with the previous one, and until now can be interpreted only in terms of configuration mixing considerations. (auth)

10984 ISOBARIC ANALOGUE RESONANCES STUDIED BY (p,p') REACTIONS ON ^{170}Yb, ^{172}Yb, ^{174}Yb, AND ^{176}Yb. Foissel, P.; Cassagnou, Y.; Lamehi-Rachti, M.; (and others) (CEN, Saclay, France). Nucl. Phys.; A178: No. 2, 640-72(1972).

Excitation functions of elastic and inelastic scattering leading to the 0^+, 2^+, 4^+ and 6^+ states of the ground state rotational bands have been measured in the energy range E_p = 10 to 15 MeV. The excitation functions of the 4^+ and 6^+ states have been calculated with a multilevel formula for the analogues of the levels identified by (d,p) reactions and compared to the experimental ones. The resonance energies and the total widths were extracted from elastic scattering and the partial widths were calculated using Nilsson coefficients. A calculation including interferences between Coulomb excitation and analogue resonances has been compared to the excitation functions of the 2^+ state. In the energy range corresponding to about 1 MeV above the parent ground state analogue a rather good agreement between experiment and calculation has been obtained though some unexplained discrepancies have been observed. At higher energy the agreement is worse; assignments of rotational bands by (d,p) measurement could not be confirmed. The ΔE_c values calculated from resonance energies were systematically smaller than the values calculated from usual semi-empirical formula; this difference was attributed to the deformation of these nuclei. (auth)

10985 HALF-LIVES OF $^9/_2{}^+$ LEVELS IN SOME ODD-MASS Rh AND Ag NUCLEI. Jain, H. C. (Tata Inst. of Fundamental Research, Bombay); Bhattacherjee, S. K.; Baba, C. V. Nucl. Phys.; A178: No. 2, 437-48(1972).

The half-lives of the $^9/_2{}^+$ levels in ^{103}Rh (93 keV, T = 1.13 ± 0.03 ns), ^{105}Rh (149 keV, $T_{½}$ < 0.3 ns), ^{107}Ag (126 keV, $T_{½}$ = 2.85 ± 0.10 ns, ^{109}Ag (132 keV, $T_{½}$ = 2.60 ± 0.12 ns) and ^{111}Ag (130 keV, $T_{½}$ = 0.92 ± 0.04 ns) have been measured by delayed coincidence technique. The M1 retardation and E2 enhancement factors for

$9/2^+ \rightarrow 7/2^+$ transitions are deduced. The structure of the $7/8^+$ level is discussed on the basis of these results. (auth)

10986 GROUND STATE ROTATIONAL BANDS IN DOUBLY EVEN ACTINIDE NUCLEI. Schmorak, M.; Bemis, C. E. Jr.; Zender, M. J.; Gove, N. B.; Dittner, P. F. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A178: No. 2, 410-16(1972).

The γ-ray spectra following the α-decay of several doubly even actinides were studied. The deduced level energies of the ground state rotational bands were compared with the collective model and the VMI model. The VMI model gave an excellent fit to the experimental levels; no phase transitions were observed in the actinide region, in contrast to the situation in the rare-earth region. (auth)

10987 RECENT PROGRESS IN MUONIC ATOMS. I. THE NUCLEAR MONOPOLE CHARGE DISTRIBUTION. Wu, C. S.; Wilets, L. (Columbia Univ., New York). Comments At. Mol. Phys.; 2: No. 5, 137-46(Dec 1970-Jan 1971).

The character of the negative muon as a probe for the static properties of nuclei is reviewed briefly. The determination of nuclear monopole charge distributions from observations of muonic x rays is discussed. Model-independent parameters of nuclear charge distribution are considered. Nuclear charge distributions derived from muonic x rays are compared with those derived from electron-scattering data; agreement is good. (A.G.W.)

Nuclear Theory

Refer also to abstracts 10426, 10504, 10527, 10535, 10747, 10766, and 10827.

10988 (EFI-TF-5(70)) ADIABATIC MODEL OF NONAXIAL NUCLEI WITH A SPIN OF 5/2 AND 7/2. Sardaryan, R. A. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). 1970. 32p (In Russian). Dep. NTIS (U. S. Sales Only).

A model of odd-mass atomic nuclei consisting of a core and external nucleon moving in the core's field is considered. The nuclear core may have a nonaxial shape but the nonaxiality must not be large. The external nucleon has conserved total angular momentum and its z component. The effect of nonaxiality on ground and anomalous bands is discussed. The rotational spectra of nuclei (ground and anomalous bands) based on a single-particle state with a spin of 5/2 and 7/2 are readily described by two parameters. Spectra of nuclei of ^{183}Re, ^{185}Re, ^{187}Re, ^{169}Yb, ^{171}Yb, ^{173}Yb, ^{169}Er, ^{171}Er with the ground state spin 5/2 and nuclei of ^{165}Ho, ^{177}Lu, ^{165}Dy, ^{169}Yb, ^{175}Yb, ^{167}Er, ^{169}Er, ^{171}Er, ^{177}Hf, and ^{179}Hf with the ground state spin 7/2 are compared with the theory. (auth)

10989 (INP-759) INFLUENCE OF SHORT-RANGE CORRELATIONS ON NUCLEON EMISSION IN ELECTRON SCATTERING BY NUCLEI. Malecki, A.; Picchi, P. (Institute of Nuclear Research, Krakow (Poland)). May 1971. 11p. Dep. NTIS (U. S. Sales Only).

The nucleon emission induced by high-energy electrons is analyzed in three experimental situations: electron-proton coincidence and single detection of electron or proton. The coincidence and proton detection experiments are recommended as sensible tools for studying the nuclear correlations. (auth)

10990 (ITF-71-31-P) LECTURES ON NUCLEAR THEORY. 4. Sitenko, A. G.; Tartakovskii, V. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 68p. (In Russian). Dep. NTIS (U. S. Sales Only).

A continuation of the course of lectures on nuclear physics presented at the Kiev State University for the students specializing in the field of theoretical nuclear physics is given. An account is given of the foundations of modern concepts on the structure of the atomic nucleus. Shell structure of nuclei is discussed. Detailed consideration is given to the one-particle shell model, as well as to the many-particle shell model. A detailed classification of many-particle states is introduced, and at the same time the necessary elements of group theory are listed. (auth)

10991 (ITF-71-34-P) LECTURES ON NUCLEAR THEORY. 5. Sitenko, A. G.; Tartskovskii, V. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 49p. (In Russian). Dep. NTIS (U. S. Sales Only).

A continuation of the course of lectures on nuclear theory given at the Kiev State University for the students who specialize in theoretical nuclear physics is given. The lectures present the basic up-to-date concepts in the structure of the atomic nucleus. The many-particle oscillatory shell model is discussed. The questions of separating the nuclear center-of-inertia motion and of false states are investigated. The affinity coefficient approach is expounded. An intermediate binding is described for the model, by means of which the energy spectra of light nuclei are examined. A number of interesting applications of the shell model are given as exercises. (auth)

10992 (JINR-E4-6055) NONROTATIONAL STATES OF ODD-Z DEFORMED NUCLEI IN THE REGION $153 \leq A \leq 177$. Solov'ev, V. G.; Fedotov, S. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 28p. Dep. NTIS (U. S. Sales Only).

The energy and structure of the non-rotational excited states for a number of odd-Z deformed nuclei in the region $153 \leq A \leq 177$ were calculated in the framework of the superfluid nuclear model. The calculations were performed with the Saxon-Woods single-particle energies and wave functions. A satisfactory agreement of the experimental and theoretical data was obtained. The position and the structure of a large number of new levels in the nuclei in question is predicted. (auth)

10993 (LA-DC-13025) WHAT CAN THE ISOMER SHIFT TELL US ABOUT NUCLEI? Rinker, George A. Jr. (Los Alamos Scientific Lab., N. Mex.). [1971]. 24p. (CONF-710933-1). Dep. NTIS.

From Muon physics conference; Fort Collins, Colo. (6 Sep 1971).

Some problems which remain to be solved in order to have a straightforward interpretation of isomer shifts in muonic atoms are discussed. The usefulness of the isomer shift as a tool which may be used to obtain nuclear structure information is demonstrated. Some examples for the lead region are summarized. (J.W.R.)

10994 (NP-19048) MATRIX ELEMENTS FOR ELECTRIC TRANSITIONS IN NUCLEI. Research Report No. 6/1971. Joenperae, I.; Haemaelaeinen, R. M. K. (Jyvaskyla Univ. (Finland). Dept. of Physics). Jul 1971. 22p. Dep. NTIS (U. S. Sales Only).

The matrix elements for electric transitions are generated on the basis of the form $\vec{A} = \vec{A}' + \nabla S$ of the vector potential. Three different decompositions are treated. It is concluded that the portion into matrix element, which comes from interaction dependent (current) terms is strongly dependent on the type of decomposition. The degree of usefulness of Siegert's theorem in its conventional form is found to be dependent on the type of decomposition. Of the cases treated here, Siegert's theorem seems to be more useful than that of Rose. Siegert's theorem is found to be invalid at normal absorption energies of some hundred MeV, and approximately valid at normal emission energies of some MeV or less. (auth) (Finland)

10995 (ORO-3765-39) PAULI BREAK-UP IN DEUTERON REACTIONS. Technical Report No. 72-044. Gambhir, B. L. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug 1971. 149p. Dep. NTIS.

Thesis.

The binding energy of a model deuteron propagating in the presence of a nuclear fermi gas is calculated as a function of the nuclear density and deuteron kinetic energy. The results show that the neutron-proton system is unbound in the presence of nuclear matter unless it has a kinetic energy at least of the order of 100 MeV. This change in binding energy arises from the phase space restrictions imposed by the Pauli exclusion principle. To investigate the importance of the Pauli mechanism in nuclear reactions, a theoretical study of the deuteron breakup reaction is performed. Although the deuteron break-up reaction is a 3-body problem with usual divergence difficulties, a Hilbert-Schmidt integral equation is obtained for the break-up amplitude from which the Pauli term can be singled out. The corresponding Pauli break-up cross sections for deuterons on ^{16}O nucleus have been calculated in a simple model. Important features of energy and angular correlations are discussed. The variation of cross-sections with incident energy and nuclear density is also studied. The magnitudes of the Pauli break-up cross-sections (e.g., a peak value of 100 mb/Sr^2 MeV at forward angles and for an incident energy of 91 MeV) guarantee that for forward angles and intermediate energies, an accurate and complete description of reactions involving deuterons must not omit the Pauli mechanism. Finally, for the deuteron elastic scattering and stripping reactions also, Hilbert-Schmidt integral equations are obtained in which the Pauli term can be isolated. From considerations of an artificially tightly bound deuteron, some qualitative inferences regarding the importance of the Pauli mechanism in α-particle reactions are also drawn. (auth)

10996 (RLO-1388-149) ft-ASYMMETRY IN MIRROR GAMOW-TELLER β-DECAY: BINDING ENERGY EFFECTS. Wilkinson, D. H. (Washington Univ., Seattle). [1971]. 11p. Dep. NTIS.

The systematic asymmetry observed between positron and negatron emitters in mirror Gamow-Teller β decay is shown not to be due to binding energy differences between the respective β-transforming nucleons; it must be due either to a fundamental weak interaction effect or to a nuclear structure effect of some type not yet quantitatively discussed. (auth)

10997 (TRI-71-6) PARTICLE FLUXES FROM TARGETS BOMBARDED WITH 500 MeV PROTONS. Simon, William G. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). Jul 1971. 24p. Dep. NTIS (U. S. Sales Only).

Graphs are given for particle fluxes from oxygen-16, copper-65, and lead-207 targets in the TRIUMF proton area. The results are given in terms of various types of particle fluxes from the target only at a distance of one meter from the target. (J.F.P.)

10998 NUCLEAR REACTIONS AND NUCLEAR STRUCTURE. Hodgson, P. E. International Series of Monographs on Physics. Oxford; Clarendon Press (1971). 673p. £14.50.

The subject is considered under the following headings: the nuclear potential, the shapes and sizes of nuclei, the theory of elastic and inelastic scattering, the theory of nuclear reactions, the optical model, the theory of the optical potential, the optical model analysis of elastic scattering, the optical model of nucleon scattering, the spin and isospin dependence of the nucleon optical potential, the scattering of composite particles, compound-nucleus reactions, fluctuations in nuclear reactions, inelastic scattering, resonances in nuclear reactions, one-nuclear transfer reactions, multi-nucleon transfer reactions, charge-exchange and knock-out reactions, intermediate states in nuclear reactions, isobaric analog state reactions, and nuclear-structure analysis. (UK)

10999 THEORETICAL PREDICTIONS CONCERNING SUPER-HEAVY ELEMENTS. Johansson, T.; Nilson, S. G.; Szymanski, Z. (Tekniska Hoegskoland, Lund, Sweden). Ann. Phys. (Paris); 5: No. 6, 377-416(Nov 1970).

The problem of the existence of islands of relative nuclear stability outside of the "stability peninsula" of presently studied elements is reviewed on the basis of various theoretical investigations. Most emphasis is put on smooth extrapolations of one-body nuclear potentials to higher A-values but calculations based on a many body treatment of various semirealistic or effective two-body interactions are also discussed. Different distortion parametrization schemes are compared. Various aspects of the calculations are reviewed such as the application of the Strutinsky shell correction method, and the treatment of pairing in the extrapolations to new mass values and new distortions. The criticality of the estimates of the inertial parameters for the fission half-life evaluations is also considered. The existence of a Z = 114 and N = 184 island of elements with relatively long half-lives is in complete agreement with theoretical investigations reviewed. (France)

11000 FISSION SYMMETRY AS A FUNCTION OF EXCITATION ENERGY. Ohta, K. (Tokyo Univ.). Lett. Nuovo Cim.; 2: No. 14, 689-94(2 Oct 1971).

A theory for the dependence of mass asymmetry of fissioning nuclei on the compound excitation energy is formulated which is analogous to Stoner's model of ferromagnetism of transition metals. A formula for the peak-to-valley ratio of the mass yield curve is developed which gives good agreement with experiment. (J.W.R.)

11001 SEPARABLE APPROXIMATION OF THE GREEN FUNCTION FOR A FINITE RANGE POTENTIAL EXTENDED BY THE COULOMB POTENTIAL. Gignoux, C. (Univ., Grenoble, France). J. Phys. (Paris); 32: No. 7, 467-73(Jul 1971). (In French).

A separable approximation for the Green function is given for a finite range potential that can be extended with the Coulomb potential. This expansion, depending upon energy, is constructed about the states introduced by P. L. Kapur and R. Peierls. The approximated Green function has the correct asymptotic behavior and the correct residues for the bound state poles. Tests given here for the square well and the Saxon-Woods potential indicate a possibility of using this separable expansion to solve the three body problem and in coupled channel calculations. (France)

11002 NUCLEAR APPLE. Mathews, P. T. London; Chatto and Windus (1971). 158p. £2.00.

The subject is considered in the following sections; classical physics, relativity and the quantum, the nucleus, strong and weak interactions, electric and baryon charges, hypercharge, complexities of weak interactions with regard to space and time, patterns of matter. (UK)

11003 SCATTERING BY MODIFIED GAUSSIAN POTENTIAL. Krori, K. D.; Borgohain, P. (Cotton Coll., Gauhati, India). Indian J. Pure Appl. Phys.; 6: No. 12, 674-7(Dec 1968).

The Gaussian potential has been modified taking into account the possible physical conditions obtaining inside and outside a spherical nucleus and certain aspects of scattering have been discussed in the light of this modified potential. Small nuclei have also been treated as a special case. (auth)

11004 RAPID EVALUATION OF FOUR-BODY CLUSTER CONTRIBUTIONS. Mueller, G. P. (Naval Research Lab., Washington, D. C.). Comput. Phys. Commun.; 2: No. 4, 214-22(May-Jun 1971).

A method is presented for rapidly evaluating the four-body contributions to the ground state energy of alpha matter within the framework of the cluster expansion formalism. A program listing and test run output of FOURBODY, the computer code for performing the evaluation, are presented. FOURBODY is written in FORTRAN for the CDC 3800. (J.W.R.)

11005 COMPUTATION OF BRODY-MOSHINSKY BRACKETS. Lejeune, A. (International Centre for Theoretical Physics, Trieste, Italy); Jeukenne, J. P. Comput. Phys. Commun.; 2: No. 4, 231-7(May-Jun 1971).

A program for computing the Brody-Moshinsky brackets which appear in the calculation of two-body matrix elements for harmonic oscillator wave functions is presented. Matrix elements of this type are seen in Hartree-Fock and shell-model calculations. The program is written in FORTRAN IV for the IBM 360/65. A flow chart and test run output for the program are included. (J.W.R.)

11006 GENERALIZED ENERGY EXCHANGE KERNEL FOR INELASTIC NEUTRON SCATTERING AND THERMONUCLEAR REACTIONS. Williams, M. M. R. (London Univ.). J. Nucl. Energy; 25: No. 10, 489-501(Oct 1971).

A general energy exchange kernel is obtained for use in the Boltzmann equation, which will account for nuclear reactions of the general type A + B → X + Y. By appropriately choosing certain parameters, the kernel may be specialized to the case of inelastic neutron scattering by a nucleus with an arbitrary distribution of levels. Also, by averaging over the appropriate thermal distribution, the differential cross section for the reaction products in a thermonuclear plasma may be calculated. For the special case of elastic neutron scattering this kernel reduces to that of the gas model of neutron thermalization. The neutron energy distribution emerging from an enclosed thermonuclear plasma is computed and the average neutron energy and the dispersion of the spectrum are calculated. (auth)

11007 COULOMBIAN CORRECTION TO THE PHASE FACTOR IN THE DIFFRACTION THEORY OF THE SUBCOULOMBIAN SCATTERING. Leclercq-Willian, C. (Institut Internuniversitaire des Sciences Nucleaires, Brussels). J. Phys. (Paris); 32: No. 7, 475(Jul 1971).

The semi-classical method of Coulombian excitation theory is used to define the elastic differential cross sections and inelastic deexcitation cross sections of a one λ phonon vibrational nuclear level with subcoulombian scattering of α particles. The interference of Coulombian and nuclear interactions modifies the diffraction structure at small scattering angles. The theoretical results presented are applied to the study of elastic scattering, $^{58}Ni(\alpha,\alpha)^{58}Ni$, and inelastic scattering, $^{58}Ni(\alpha,\alpha')^{58}Ni$, with excitation of the 2+ and 3- levels of ^{58}Ni. (France)

11008 PICK-UP FORM FACTORS FOR (p,α) REACTIONS. Suck, S. H.; Coker, W. R. (Univ. of Texas, Austin). Nucl. Phys.; A176: No. 1, 89-96(1971).

A simple method for computation of semi-microscopic, zero-range three-nucleon transfer form factors for use in DWBA calculations is proposed and applied in two examples: $^{92}Zr(p,\alpha)^{89}Y(1/2^-$ g.s. and $3/2^-$, 1.51 MeV) and $^{90}Zr(p,\alpha)^{87}Y(1/2^-$ g.s. and $3/2^-$ 0.38 MeV). (auth)

11009 FOLDED-DIAGRAM EXPANSION OF THE MODEL-SPACE EFFECTIVE HAMILTONIAN. Kuo, T. T. S. (State Univ. of New York, Stony Brook); Lee, S. Y.; Ratcliff, K. F. Nucl. Phys.; A176: No. 1, 65-88(1971).

A linked-diagram expansion for the model-space effective Hamiltonian is derived. This expansion which contains the folded diagrams is independent of the energy eigenvalue. The result is generally in agreement with the expansion obtained earlier by Brandow, Morita, and Oberlechner et al., but the method of derivation is different and is probably simpler. The properties of the model-space wave functions and their connection with the true eigenfunctions are investigated. In particular, a linked-diagram expansion is obtained for the evaluation of the expectation value of a general operator with respect to the true eigenfunction. This expansion also contains the folded diagrams and is independent of the energy eigenvalues. (auth)

11010 CENTER-OF-MASS CORRECTIONS IN NUCLEAR SELF-CONSISTENT FIELD THEORIES. Davies, K. T. R.; Becker, Richard L. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A176: No. 1, 1-22(1971).

Of various methods for making c.m. corrections to nuclear wave functions, one is found to be particularly suitable for calcula-

tions of the Hartree–Fock type, including those of Brueckner theory. For a spherical nucleus, expressions are derived for the corrections to the single-particle potential, the single-particle energies, the separation energies, the total binding energy and the rms mass, proton and neutron radii. The matrix formulation of Hartree–Fock theory in a harmonic-oscillator basis is employed. The limiting case of the single-oscillator configuration is discussed. Questions arise concerning the c.m. corrections when the Brueckner theory is renormalized with occupation probabilities. It is argued that within the Brueckner–Hartree–Fock approximation it is more accurate not to renormalize the c.m. corrections. (auth)

11011 THEORY OF MANY-BODY WAVE FUNCTIONS WITH CORRELATIONS. Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). Nucl. Phys.; A176: No. 1, 205-18(1971).

A systematic theory of the "best" many-body wave functions in terms of functions with "no correlations" (Hartree–Fock (HF) or shell-model (SM) wave functions), "two-body correlations," "three-body correlations" etc. is given. This either may be done by applying a projection technique or a variational procedure. The resulting equations are coupled generalized HF (GHF) equations, generalized Bethe–Goldstone (GBG) equations and so on. This procedure is unambiguous for hard-core potentials: one does know exactly where to truncate the set of equations if one wants to stop at a certain level of correlations. (auth)

11012 APPLICATION OF THE METHOD OF NUCLEAR PERTURBATION SCATTERING THEORY FOR PAIRS OF SPACES. Deich, V. G. Izv. Vyssh. Ucheb. Zaved., Mat.; No. 6, 33-42(Jun 1971). (In Russian).

Abstract criteria for the existence of complete isometric wave operators in scattering theory is discussed as related to pairs of spaces. A previously suggested proposition by another author is developed for the "degeneracy" problem. The requirement of continuity of the sign property of the medium was eliminated, and the class of permissible unperturbed operators was broadened. (K.S.W.)

11013 ENERGY SPECTRUM OF THE RELATIVISTIC ROTATOR. Kraev, M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 77-80(1971). (In Russian).

The energy spectrum of the rigid relativistic rotator is determined according to Klein–Gordon and Dirac equations. Expressions for the energy are given in each case. (auth)

11014 OPTICAL POTENTIAL FOR HIGH-ENERGY ELECTRON SCATTERING. Petkov, I. Zh. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 159-64(1971).

At high electron energies and large scattering angles, excitation of the nucleus (virtual excitation in the case of elastic scattering) can prove to be important. This phenomenon is considered, with monopole excitation effective through one excited level included. The scattering amplitude is obtained by using the high-energy approximation. The amplitude is compared with the elastic potential scattering amplitude to extract the effective potential of the electrons. Inclusion of a fictitious excited level, the energy of which is unknown, introduces additional parameters; the magnitude of this energy can be approximated from the total inelastic cross section. Complications arising when the energy loss of the electrons is taken into account are sketched. (R.W.R.)

11015 STRUCTURE FACTOR IN A MANY-BODY SYSTEM WITH AN ATTRACTIVE INTERPARTICLE YUKAWA POTENTIAL. Weil, J. W. (Univ., Innsbruck). Acta Phys. Pol.; A40: No. 3, 395-6(Sep 1971).

The structure factor of a many-body system with Yukawa-type interparticle potentials is derived; its connection with thermodynamics is mentioned. (auth)

11016 DIFFRACTION SCATTERING OF THE PARTICLES BY ORIENTED NUCLEI. Inopin, E. V.; Tishchenko, B. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 585-9(Apr 1971). (In Russian).

General expressions are obtained for the cross sections for heavy-particle scattering by oriented nuclei. Elastic and inelastic scattering cross sections are analyzed. (auth)

11017 ALLOWANCE FOR THE WAVE FUNCTION DISTORTION UNDER MULTIPOLE ANALYSIS OF FAST NUCLEON SCATTERING BY NUCLEI. Sitenko, A. G.; Fursa, A. D.; Dotsenko, I. S. (Inst. of Theoretical Physics, Kiev. Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 6, 881-93(Jun 1971). (In Russian).

Allowance is made for wave-function distortion in the initial and finite states within the framework of the multipole formalism in describing high-energy nucleon scattering by nuclei. The distorted optical potential is calculated on the basis of the two-nucleon interaction in accordance with multiple scattering theory. Numerical calculations are carried out of angular distributions from elastic scattering of protons by ^{12}C nuclei, as well as from inelastic scattering with excitation of 0^+, 1^+, 2^+ and 3^- levels when $T = 0$ and 1^+ and 2^+ levels when $T = 1$. A comparison with the experimental data is carried out for a proton energy of 185 MeV. The character of angular dependence and the absolute magnitude of the cross sections in most cases are in good agreement with the experimental values. (auth)

11018 REPRESENTATION BASIS EFFECTS ON THE NUCLEAR HARTREE–FOCK FIELD. Jeukenne, J. P. (Univ., Liege); Lejeune, A. Bull. Soc. Roy. Sci. Liege; 40: No. 3-4, 127-36(1971).

A system of Hartree-Fock equations is developed for doubly magic spherical nuclei in the harmonic oscillator representation and using the Brink interaction. The influence of the representation basis on the properties of the resulting nuclear HF field is discussed. (tr-auth)

11019 THEORY OF PION–NUCLEAR SCATTERING LENGTHS. Moyer, LeRoy Donald. Rochester, N. Y.; Univ. of Rochester (1971). 157p. University Microfilms Order No. 71-22,309.

Thesis.

The impulse or single-scattering approximation for zero-energy pion–nucleus scattering gives results in disagreement with the experimental scattering lengths obtained from pionic atoms. Multiple-scattering corrections to the single-scattering approximation are calculated in a simple nuclear model, and it is shown that double scattering of the pion can account for a major portion of the disagreement. In the calculation the double scattering is broken into two parts. The first part, called the regular double scattering, treats the situation where the pion scatters on two different nucleons. The second part, is called the binding correction because it is a correction to the single scattering from a pion scattering twice on the same bound nucleon. The largest contribution in both double scattering terms involves the incoherent excitation of the nucleus, and is not included in most optical models. The effects of higher-order multiple scattering are also estimated as well as other, small effects, such as an energy-dependent pion–nucleon scattering operator. (Diss. Abstr. Int., B)

11020 ELECTRON SCATTERING FROM COMPLEX NUCLEI. PART A. Ueberall, Herbert. Pure and Applied Physics. A Series of Monographys and Textbooks. Volume 36. New York; Academic Press Inc. (1971). 490p. $24.00.

The theory of elastic scattering of electrons by point and extended nuclei is presented through the use of both the Born approximation and the accurate solution of the Dirac equation. Results discussed include elastic scattering from magnetic moments and deformed nuclei, effects of nuclear orientation, and ground-state properties obtained from muonic x-ray experiments. (873 references) (R.W.R.)

11021 FURTHER STUDIES ON FORM FACTORS FOR SINGLE-NUCLEON TRANSFERS IN DIRECT INTERACTIONS. McCallen, Gwendolyn Mary Nelson. Nashville; Vanderbilt Univ. (1971). 126p. University Microfilms Order No. 71-29,312.

Thesis.

Form factors are calculated by the approximated Pinkston–Satchler equation, which takes into account the residual interactions between the particles or holes past a closed shell. The cases studied include the $1f_{\frac{7}{2}}$ form factor in the $^{12}C(p,d)^{11}C$ transition to the $\frac{5}{2}^-$ state at 4.31 MeV, the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ form factors in the $^{14}N(p,d)^{13}N$ transition to the $\frac{1}{2}^+$ state at 2.37 MeV, the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ form factors for positive parity states at 5.19, 5.24, and 6.86 MeV on the $^{16}O(p,d)^{15}O$ and $^{16}O(^3He,^4He)^{15}O$ reactions, the $1f_{\frac{7}{2}}$ form factors for the $^{42,44}Ca(d,p)^{43,45}Ca$ transitions to the $\frac{5}{2}^-$ states at 0.373 and 0.176 MeV, and the $3p_{\frac{1}{2}}$, $2f_{\frac{5}{2}}$, $3p_{\frac{3}{2}}$, and $1i_{\frac{13}{2}}$ states in the $^{208}Pd(d,p)^{207}Pb$ reaction. The area of interest in the form factors is the tail region since the major contribution of the form factors to the DWBA integrals comes from this area. A large difference between the binding energy and the single-particle energy of the nucleon was a necessary but not a sufficient condition in order for the form factors to vary significantly from their well-depth counterparts. The largest variations in the well-depth and more realistic form factors occurred in the light nuclei, where the energy differences are the largest. In the $^{12}C(p,d)$ transition, the realistic form factor was 160% larger than the corresponding well-depth form factor in the tail region. The Ca and Pb cases showed roughly a 10% difference in the two types of form factors. The effect of the form factors was on the magnitudes and not on the shapes of the differential cross sections. The $1f_{\frac{7}{2}}$ realistic form factor in the

$^{12}C(p,d)$ reaction increased the differential cross section by a factor of 4, and the extracted spectroscopic factor decreased from 0.83 to 0.2. The results for the light nuclei were complicated by the use of a radial cut-off procedure in the DWBA calculations. Form factor calculations were carried out with a simple model that utilizes an isotopic spin-coupled wave function and the Lane isovector potential, $V_1(r)\ T \cdot t$. The model was reinvestigated in order to clarify its application to (p,d) reactions with ^{48}Ti, ^{50}Ti, ^{52}Cr, ^{54}Fe, ^{56}Fe, ^{58}Fe, ^{58}Ni, ^{60}Ni, and ^{62}Ni. The reactions resulted in T> and T< isotopic spin states in the residual nuclei. The T> form factors determined by the model were 1 to 14% smaller in the tail region than previously reported. Although the spectroscopic factors produced by the Lane potential form factors were in general closer to the theoretical values than the well-depth spectroscopic factors, the agreement was still unsatisfactory. (TSS) (Diss. Abstr. Int., B)

11022 ISOSPIN SPECTRAL AND STRENGTH DISTRIBUTIONS. Thio, Hoe Tong. Rochester, N. Y.; Univ. of Rochester (1971). 274p. University Microfilms Order No. 71-22,323.

Thesis.

Isospin effects on spectral and strength distributions are investigated. Algebraic techniques are developed to study these distributions in terms of their energy moments up to the second order. Normality of the distributions is an integral assumption of the theory, and is tested in a variety of cases for which detailed calculations are possible. A number of applications are then considered as follows. (1) Determination of ground-state energies and low-lying spectra of various nuclei in the ds and fp shells, from the isospin and configuration-isospin distributions; comparisons are made with experimental results and with shell-model calculations as far as possible. (2) Relative configuration intensities, and fractional occupancies of shell-model orbits, in the ground states of various nuclei. The first of these are of major value in deciding which configurations are significant in the low-lying spectrum, thereby enabling a truncation of the very large matrices encountered; the second are directly comparable with experiment. (3) The well known (4n + 2) isospin effect in light nuclei is studied with the distribution method, an example of a study of a general feature of nuclei described in large shell-model spaces. (4) Single-nucleon transfer strength distributions and the corresponding spectral distributions are contrasted to demonstrate the extent of correlation between the structures of the two nuclei involved. (5) By regarding the target ground state as a representative member of the subset averaged over, transition strengths to various states of the final nucleus are roughly calculated. (6) A beginning is made of a general study of the distribution of electromagnetic transitions in complex nuclei and illustrated by examples in the ds and fp shells. A brief outline is given also of studies of the maximization of the isospin strength splitting for nuclear transfer with respect to target ground-state configuration admixtures. A similar outline is given also for a theory of analog spin. (Diss. Abstr. Int., B)

11023 THEORY OF NUCLEAR LEVEL DENSITIES WITH RESIDUAL INTERACTIONS. Mugambi, Paulo Edward. Rochester, N. Y.; Univ. of Rochester (1971). 158p. University Microfilms Order No. 71-22,310.

Thesis.

A theory of nuclear level densities, for fixed angular momentum and isospin, which takes account of residual interactions has been formulated. This has involved use of the spectral distribution method with the assumption that all the distributions encountered are normal. The necessary ingredients then are traces over states of fixed (J,T) of the zero'th, first, and second powers of the Hamiltonian H. In order to calculate these, they were expressed in terms of coupled partial traces of operators which operate in jj orbits and which have specified angular momentum and isospin ranks in each of them. The single-orbit traces, which have other uses apart from their application to level densities, were constructed via a method inductive in particle number. A result is that the level densities produced are decomposed in terms of configurations, a feature which should be of value in their later applications. The entire formulation is such that arbitrary residual interactions may be taken account of. Computations of the essential ingredients have been made only for $j \leq 5/2$ but no essential problems are envisaged for higher orbits. Only minor applications to (ds) shell nuclei have so far been made. The distributions of various configurations, and the general form of the distributions in angular momentum at fixed energy, have been studied for 4, 6, and 9 particles. It is found that the usual Gaussian form for the angular momentum distributions is well justified, the spin cut-off factor being roughly the same for each of the three cases and almost energy-independent except for a gradual decrease in the 4-particle case. (Diss. Abstr. Int., B)

11024 NEW METHODS FOR NUCLEAR SPECTRA AND LEVEL DENSITIES. Chang, Fou-sen. Rochester, N. Y.; Univ. of Rochester (1971). 181p. University Microfilms Order No. 71-22,288.

Thesis.

The theory of spectral distributions and its applications are discussed. A formalism is constructed for the first two moments for the scalar, fixed-configuration, and fixed configuration fixed-isospin distributions, based on decompositions of the Hamiltonian with respect to the group U(N) of transformations in the single-particle basis, and its subgroup $\Sigma_i U(N_i)$ which defines configurations. Measures have been introduced for the size of each orthogonal part of the Hamiltonian. The variation of these quantities with excitation energy has been studied, $(ds)^{12}$ with a Rosenfeld interaction being chosen for an example. A new tensor-multiplication method for spectral moments was also investigated. There is considerable evidence that the spectral distributions are basically normal. Based on this the distributions defined by the two lowest moments are used to study nuclear level densities, the resultant theory taking full account of orbital structure and residual interaction. To begin with, methods for determining the ground-state energy are studied and the ground-state energies of many ds-shell nuclei calculated and compared both with exact calculations and with experiment, the discrepancies in almost all cases being less than 1 MeV. This procedure, which is applied also to low-lying spectra, fixes the zero with respect to which the excitation energy used in the level density is defined, but it is of course of much more general interest. The effects of the residual two-body interactions on level density have been discussed in detail. Typical cases of low-lying state densities (without angular momentum specifications) in light nuclei have been calculated, taking account of all residual interactions; the results show good agreement when compared with experimental data. The "spin cut-off" factor and a fourth-moment correction to the elementary central limit theorem, results for the J-dependence of the level density, have been evaluated and used to calculate level density; the first preliminary results show good agreement with exact calculations, but the calculated densities are too small compared with experimental data, this showing the necessity, as we go up in excitation, of extending the orbital space which is used. Such orbital extensions have been studied. All the indications are that when a sufficiently large orbital space is used the resultant theory of level density is accurate and should replace the largely ad hoc theories used heretofore. For detailed spectra a method of combining exact calculation in a small dominant subspace is introduced along with a statistical correction to these results to take account of the space ignored. Various stochastic approximations have been introduced and one of them seems to be quite promising. (Diss. Abstr. Int., B)

11025 BREMSSTRAHLUNG ACCOMPANYING NUCLEAR ELASTIC SCATTERING. Richards, Floyd Clark. Seattle; Univ. of Washington (1971). 229p. University Microfilms Order No. 71-24,074.

Thesis.

The cross section for bremsstrahlung radiation accompanying elastic scattering of light nuclear projectiles from a target nucleus is calculated. The projectile-nucleus interaction is represented primarily by a complex optical model potential, and a perturbation treatment of effects due to residual nucleon–nucleon forces is included. Bremsstrahlung provides a means of measuring off-mass-shell optical model matrix elements, which are required for standard analyses of nuclear reactions but have not previously been investigated. Contributions from giant dipole intermediate state excitations of the target nucleus and from double scattering diagrams, in which nuclear scattering occurs both before and after the photon is radiated, are calculated, and contributions involving compound nucleus intermediate states are estimated. The formulation is applied to the $^3H + ^{16}O$ system at 10.1 MeV c.m. incident energy, and it is found that double scattering is as important as single scattering, but that effects due to residual forces are relatively unimportant. Approximations associated with the treatment of Coulomb effects are verified by checking gauge invariance of the calculated bremsstrahlung amplitude in the soft photon region, where a unique check is possible. In addition, it is found that a widely accepted expression for the off-mass-shell Coulomb scattering amplitude is in conflict with the gauge invariance requirement and is therefore incorrect; a correct expression is given and it is shown that it satisfies gauge invariance. Radiative cross sections due to different potentials yielding equivalent fits to triton-oxygen elastic scattering data are compared. It appears that rather accurate measurements of nuclear bremsstrahlung would be necessary to determine which, if any, potential is correct. This determination might even be impossible if radiation from compound nuclear intermediate states is slightly more important than indicated by our estimate. (Diss. Abstr. Int., B)

11026 SATURATION OF NUCLEAR FORCES IN NUCLEAR MATTER. Ulehla, I. (Charles Univ., Prague). Czech. J. Phys.; 21: No. 10, 1059-63(1971).

The problem of saturation in nuclear matter is considered when the two-nucleon interaction is described by the soft-core potentials acting in a limited number of orbital states. The potentials used belong to the class of the realistic potentials. (auth)

11027 NOTE ON THE TRUNCATION OF THE BASIS IN HARTREE–FOCK CALCULATION. Zofka, J. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys.; 21: No. 10, 1051-8(1971).

Hartree–Fock calculations for nuclei in the 2s–1d shell were performed using different truncations of the basis with a density-dependent force. The influence of these truncations on the Hartree–Fock solutions is analyzed. The primary influence is on the stability, shape, and center-of-mass motion energy of the nuclei studied. (auth)

11028 NUKLONNYE ASSOTSIATSII V LEGKIKH YADRAKH. (Nucleon Associations in Light Nuclei). Neudachin, V. G.; Smirnov, Yu. F. Moscow; Izdatel'stvo Nauka (1969). 416p.

Alpha decay and the emission by nuclei of such complex particles as deuterons, tritons, and α particles in various nuclear reactions all furnish evidence as to the specific substructure of the nucleus—the "nucleon association." This book attempted to describe nucleon association in model structures of light nuclei, and offers methods of estimating diverse nuclear reactions that concern nucleon association. Examples are γ transitions in nuclei; scattering of fast electrons by nuclei; resonance, direct, and photonuclear reactions; reactions of quasi-elastic knock-out; and the absorption of π mesons by nuclei. The concepts of group representations, SU_3, SU_4, and Racah algebra are discussed in connection with several models. (180 references) (tr-auth)

11029 SINGLE-PARTICLE WAVEFUNCTIONS OF ^{12}C FROM A HIGH ENERGY (p,2p) EXPERIMENT. McCarthy, I. E.; Pal, D.; Storer, R. G.; Thomas, A. W. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys.; 24: No. 5, 661-9 (Oct 1971).

The 385-MeV $^{12}C(p,2p)^{11}B$ experiment of James et al., is analyzed by means of a distorted-wave method with the purpose of determining two parameters describing each single-particle state: the r.m.s. radius ρ_{nlj} for an effective spherical potential and a reduction factor S_{nlj} to take account of absorption. The values of ρ_{nlj} are consistent with electron scattering evidence. The reduction factors are determined consistently from the angular correlation and the absolute magnitude of the cross section. (auth)

11030 RELATIONSHIP BETWEEN THE WIDTH FOR DECAY FROM A DOORWAY STATE AND THE RATIO BETWEEN THE NUMBERS OF THE CORRELATING AND OPEN CHANNELS. Hsu, C. C. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 28: No. 1, 45-7(3 Jan 1972).

The width, $\langle\Gamma_d\uparrow\rangle$, for the decay out of the doorway state is derived as a function of the average total level width, $\langle\Gamma_\mu\rangle$; the channel correlation coefficient, $C_{cc'}$; the ratio between the number, n_d, of the correlating channels and the number, n, of the open channels; and the level-overlapping ratio, $\langle\Gamma_\mu\rangle/D$. With the function as a basis, the relation between the ratio n_d/n and the width $\langle\Gamma_d\uparrow\rangle$ and the ratio $\langle\Gamma_\mu\rangle/D$ is discussed. The results indicate that the latter relation is in agreement with the experiment of Shotter, Fisher, and Scott [Nucl Phys., 159: 577(1970)]. (auth)

11031 REACTIONS TO UNBOUND FINAL STATES. Strohbusch, U.; Koerner, H. J.; Morrison, G. C. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 28: No. 1, 47-50(3 Jan 1972).

It is pointed out that the strength of (^{3}He,d) reactions to unbound states is correlated with the penetrability for proton decay of these states. The anomalously weak transitions to s states fit into this pattern. Additional data from the reaction $^{116}Sn(^3He,d)^{117}Sb^*$ are presented, Some questions regarding extrapolations to other reactions are raised. (auth)

11032 VARIATIONAL CALCULATION OF THE QUADRUPOLE DEFORMATION ENERGY OF THE ^{12}C NUCLEUS. Verwoerd, W. S. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A178: No. 2, 479-87(1972).

A variational calculation for the ground state of the ^{12}C nucleus is carried out, using a Slater determinant of cylindrical oscillator wave functions as a trial wave function. A Brink and Boeker type two-particle interaction yields the total energy E of the nucleus as a function of the oscillator parameters. This is minimized subject to the constraint of constant intrinsic quadrupole moment Q to obtain E as a function of Q. The results for binding energy, radius, deformation and single-particle energies compare well with the experimental values and with the results obtained using more sophisticated Hartree–Fock procedures. (auth)

11033 UNITARY POLE EXPANSION OF THE OFF-SHELL t-MATRIX ELEMENTS FOR LOCAL POTENTIALS WITH HARD CORES. Mathur, V. S.; Lagu, A. V.; Maheshwari, C. (Banaras Hindu Univ., India). Nucl. Phys.; A178: No. 2, 365-74(1972).

A convenient separable expansion of the t-matrix, similar to the one developed recently by Harms for local potentials with soft cores, has been obtained in the case of a hard-core potential as well. The unitary pole expansion (UPE), as it is called, is found to be strongly convergent. The UPE values of the off-shell t-matrix elements for a hard-core potential with an exponential shape agree fairly well with those obtained by Laughlin and Scott from the direct solution of the inhomogeneous Lippman–Schwinger equation. (auth)

11034 UNIQUE FIRST-FORBIDDEN β-DECAYS AND SPIN–ISOSPIN CORE POLARIZATION. Ejiri, H. (Osaka Univ.). Nucl. Phys.; A178: No. 2, 350-4(1972).

Matrix elements of unique first-forbidden β transitions in mass region $A \approx 90$ are analyzed. The experimental values are uniformly smaller by a factor ≈ 3 than the calculated values on a conventional pairing model. The reductions of the unique transitions are discussed in terms of a spin–isospin core polarization. Microscopic calculations for the transition matrix elements are made in a framework of random phase approximation. The observed reductions are reproduced by using the spin–isospin polarization interaction $H_{\tau\sigma} = \chi_{\tau\sigma}\tau_1 \cdot \tau_2\sigma_1 \cdot \sigma_2 r_1 \cdot r_2$ with $\chi_{\tau\sigma} = 0.36$ MeV · fm^{-2}. (auth)

11035 TRIPLE-SCATTERING PARAMETERS IN OPTICAL-MODEL ANALYSES. Clarke, N. M. (King's Coll., London). Nucl. Phys.; A178: No. 2, 513-28(1972).

An optical-model program has been modified to include and fit nucleon–nucleus triple-scattering data. The sensitivity of the R-parameter to values of the parameters of the optical model is discussed. An analysis of the available data is carried out and for ^{40}Ca the results using the regular optical model are compared with those obtained using an optical potential generated from a matter distribution. (auth)

11036 AVERAGE INTERACTION OF A THREE-BODY SYSTEM. Coffou, E. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb); 3: No. 4, 189-202(Oct 1971).

The first-order interaction of a three-body system was considered. An exact solution of the three-body problem was used for the three-body wave function. The average interaction was expressed through the evaluation of one-dimensional integrals. Particular interactions were discussed. Characteristics of surface interactions were deduced for spin-orbit and tensor-force average interactions. (auth)

11037 DECOMPOSITION OF A THREE-BODY WAVE FUNCTION. Coffou, E. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb); 3: No. 4, 203-17(Oct 1971).

The decomposition of a three-body wave function into a series of separable functions has been considered in the case of non-separable interactions between particles. A particular complete set of functions has been singled out for which the best convergence of the expansion series has been obtained. The effective two-body force strength in a three-body system has been determined by the condition of strongest convergence. It has been shown that the effective force strength differs essentially from the strength of the two-body system. The expansion series assumes a simplified and symmetric form if effective forces are used. The interpretation in terms of the independent particle shell model is given for the residual interaction and the finiteness of the mass of the nucleus. (auth)

11038 NUCLEAR RADII IN THE HIGH-ENERGY LIMIT OF ELASTIC ELECTRON SCATTERING. Lenz, F.; Rosenfelder, R. (Univ., Freiburg i. B.). Nucl. Phys.; A176: No. 3, 513-25 (1971).

From the formula for the energy-derivative of the phase shifts a systematic high-energy expansion of the phase shifts for the elastic scattering of electrons from nuclei is deduced. The coefficients of this expansion can be arranged in terms of inverse powers of the energy containing model-independent quantities of the nuclear charge distribution. It is shown that the mean logarithmic radius $\exp[\langle \ln r\rangle]$ and the inverse square radius $\langle 1/r^2\rangle^{-\frac{1}{2}}$ determine the high-energy behavior of the phase shifts for small values of the angular momenta. Applications to the elastic electron and positron scattering from nuclei and to dispersion effects are discussed. (auth)

11039 ANALOGUE OF KOOPMANS' THEOREM ON SEPARATION ENERGIES IN THE RENORMALIZED BRUECKNER–HARTREE–FOCK THEORY. Becker, Richard L.; Patterson, M. R. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A178: No. 1, 88–96(1971).

The near equality of separation energies and single-particle energies, which holds in HF (Koopmans' theorem [Physica 1: 104 (1934)]) but fails badly in BHF, is shown analytically to be recovered in RBHF by virtue of the connection between the energy dependence of the effective interaction and the occupation probabilities of the normally occupied states. (auth)

11040 NOTE ON THE EFFECT OF WEAK MAGNETISM ON THE MIRROR $(ft)^+/(ft)^-$ RATIO. Wilkinson, D. H. (Univ. of Washington, Seattle). Nucl. Phys.; 178A: No. 1, 65–8(1971).

The role of weak magnetism in the mirror asymmetry of Gamow–Teller β decay is considered. For $Z = 0$ the interference between weak magnetism and the chief axial term vanishes identically, while for finite Z over the range of experimental interest the contribution to the mirror asymmetry does not exceed about 2×10^{-3}, against experimental effects of the order 0.13. (auth)

11041 Q-VALUE DEPENDENCE OF HEAVY-ION TRANSFER REACTIONS. Alder, K.; Trautmann, D. (Univ., Basel). Nucl. Phys.; A178: No. 1, 60–4(1971).

The dependence of transfer reactions between heavy ions on the Q value is investigated. Neutral or charged particles may be exchanged between projectile and target. The results are obtained with the semiclassical theory of transfer reactions. (auth)

11042 PROCEDURE FOR CHECKING ENERGY AND EFFECTIVE CHARGE PERTURBATION CALCULATIONS. Mavromatis, H. A.; Singh, B. (American Univ., Beirut). Nucl. Phys.; A178: No. 1, 30–8(1971).

A method is outlined for checking energy and effective-charge perturbation calculations, applicable in principle to any order, by using the c.m. potential energy written as a sum of two-body operators. This method, which is more useful for lower-order calculations, can be applied to any system; it used to check the expressions for the binding energies and spectra to second order of several simple nuclear systems, as well as the expressions for the effective charge to first order. Both cases where the lowest model state is completely nonspurious and where it is partly spurious are considered. (auth)

11043 DIFFERENCES BETWEEN THE DWBA AND A FEYNMANN-DIAGRAM APPROACH IN SUB-COULOMB HEAVY-ION NEUTRON TRANSFER REACTIONS. Anni, R. (Univ., Lecce, Italy); Taffara, L.; Vanzani, V. Nucl. Phys.; A178: No. 1, 214–24(1971).

The DWBA method and a Feynman-diagram approach [Dolinskii et al., Nucl. Phys., 76: 289(1966); Taffara and Vanzani, Nuovo Cim., 61B: 365(1969)] are applied to sub-Coulomb heavy-ion neutron transfer reactions, and the results are critically compared. Three-body intermediate-state effects, appearing in the Feynman-diagram transition amplitude, are evaluated by means of a suitable regularization procedure. Once more it is proved that the success in fitting the experimental cross-section behavior cannot be used as the unique criterion for choosing between different reaction models. (auth)

11044 HYPERONIC MATTER. Pandharipande, V. R. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A178: No. 1, 123–44(1971).

Dense hyperonic matter ($\rho \approx 10^{14-15}$ g/cm^3) is studied with two approximations for the baryon–baryon interaction based on the Reid soft-core nucleon–nucleon potential. The treatment of short-range correlations is very much simplified by restricting the correlations to nearest neighbors. A lowest-order variational theory is developed with constraints corresponding to the above restriction, and it is shown that the ground state properties of liquid ^{3}He and ^{4}He are well reproduced by it. Neutron gas is also studied by this method, with various realistic interactions. Results for the Bressel–Kerman–Rouben square-well core potential indicate a transition from correlated to uncorrelated phases at high density. The possibility of a sudden increase in density with the transition from nuclear to hyperonic matter is also discussed. The equation of state for hyperonic matter and the uncertainties in it are outlined. (auth)

11045 OFF-SHELL EFFECTS AND THE RANGE OF MOMENTUM DEPENDENCE OF THE POTENTIAL. Srivastava, M. K. (Univ. of Roorkee, India). Nucl. Phys.; A178: No. 1, 332–6(1971).

The effect of the range of p^2-dependent terms in the phase-shift equivalent potentials on the off-shell behavior is investigated. It is found that wide variations can be obtained provided the range is at least 1 fm. The reflection of these variations in any many-body calculation depends on which matrix elements play the dominant role. (auth)

11046 DIPOLE EXCITATIONS IN FISSION FRAGMENTS. Mustafa, M. G. (Oak Ridge National Lab., Tenn.); Schmitt, H. W.; Mosel, U. Nucl. Phys.; A178: No. 1, 9–16(1971).

Dipole excitations in fission fragments at the scission point are studied in a classical model. These excitations correspond to a density fluctuation caused by the Coulomb repulsion between the fragments. A simple two-sphere approximation to the scission configuration is used for these studies. The dipole density distribution is obtained from a hydrodynamic picture of the fragment nucleus, and the dipole amplitude parameters are fixed by minimizing the total potential energy at the scission point. Calculations are made for the symmetric and asymmetric scission configurations corresponding to the fission of ^{235}U by thermal neutrons. The dipole excitation energy is found to be about 0.5 MeV in one fragment, and, at the same time, the total energy is lowered by 1 MeV from its value calculated with a uniform density distribution. (auth)

11047 CALCULATION OF BINDING ENERGIES, RADII, QUADRUPOLE MOMENTS, AND MOMENTS OF INERTIA FOR LIGHT NUCLEI. Grin, Yu. T.; Kochetov, A. B.; Anan'kin, A. I. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 5, 953–60(Nov 1971). (In Russian).

Binding energies, radii, quadrupole moments, moments of inertia, and shapes of the even–even, N = Z, nuclei in the 1s–0d shell are calculated. The calculations are compared with experiment. (auth)

11048 SHELL EFFECTS IN BINDING ENERGY AND IN ONE-PARTICLE EXCITATION SPECTRUM OF FINITE FERMI SYSTEMS. Khodel, V. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 5, 961–71(Nov 1971). (In Russian).

A method to calculate the shell corrections to the binding energy of heavy nuclei is formulated in the framework of the theory of finite Fermi systems. A way to obtain parameters of the universal part of the self-consistent nuclear field is also indicated. (auth)

11049 POSSIBLE EXISTENCE OF CLOSED SHELLS IN NUCLEI WITH $Z \geq 114$. Nemirovskii, P. E.; Vinogradov, B. N. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; No. 5, 972–8 (Nov 1971). (In Russian).

Calculations of magic numbers for superheavy nuclei with the Woods–Saxon potential are presented. Stability of the obtained numbers against small variations of the parameters is verified. A method is proposed to estimate the closure of the shells using the approach of interacting configurations. (auth)

11050 PROTON POLARIZATION IN COULOMB STRIPPING REACTION (d,p) AT $l_n = 1$. Gubkin, I. A. (Leningrad State Univ.). Yadern. Fiz.; 14: No. 5, 979–85(Nov 1971). (In Russian).

Analytical expressions are obtained for differential cross section and proton polarization in the Coulomb stripping reaction (d,p) at $l_n = 1$. The features of quasiclassical description of the Coulomb stripping reaction are discussed. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Refer also to abstract 10364.

11051 METHODS OF EXPERIMENTAL PHYSICS. VOLUME 9. PLASMA PHYSICS. PART B. Lovberg, Ralph H.; Griem, Hans R. (eds.). New York; Academic Press, Inc. (1971). 316p. $16.00.

Separate abstracts were prepared for the six sections. (M.O.W.)

For abstracts of individual chapters see: 10134–10136, 11083, 11094, and 11191.

Confinement and Heating

11052 (AEC-tr-7274) TRANSPORT PROCESSES IN TOROIDAL MAGNETIC TRAPS. II. TRANSPORT PROCESSES IN WEAKLY IONIZED PLASMA. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translation of report NP-18341. 49p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 42678. (M.O.W.)

11053 (IAE-2032) LIFETIME OF IONS IN THE TOKAMAK-3 DEVICE. Artsimovich, L. A.; Gorbunov, E. P.; Petrov, M. P. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The energy and lifetime of ions were calculated for the central zone of a plasma filament in the Tokamak-3 device. Calculations were based on the ion temperature from an analysis of charge transfer in atomic spectra and on the results of plasma density measurement by a microwave interferometer. An essential fraction of heat is lost by ions through conductivity. Not over 20% of the total heat loss occurs through diffusion and charge transfer in the near-axial regions of the plasma filament in Tokamak-3. (tr-auth)

11054 (KHFTI-70-64) INVESTIGATION OF PLASMA HEATING IN A STRONG VARIABLE ELECTRIC FIELD. Grigoreva, L. I.; Sizonenko, V. L.; Smerdov, B. I.; Stepanov, K. N.; Chechkin, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 41p. (In Russian). Dep. NTIS (U. S. Sales Only).

Scattering of charged particles by turbulent pulsations of an electric field leads to effective heating of plasma. Anomalous absorption of high-frequency energy and plasma heating perpendicular to an external magnetic field had been previously observed. The present experiments showed that, during turbulent heating of plasma by fast magneto-acoustic waves, preferential heating of ions was correlated with small amplitudes, while at large amplitudes both electrons and ions were heated. The plasma was created by 18-μsec pulse discharges with oscillating electrons in hydrogen at a pressure of about 10^{-3} mm Hg. Measurement of the longitudinal energies of electrons and ions emerging from the plasma along a fixed magnetic field was accomplished with the aid of a three-network analyzer with retarding potential. Observations were also made on the instability of plasma with a transverse current, heating of electrons in the field of a turbulent plasma, and ion heating. (K.S.W.)

11055 DIFFUSION OF A PLASMA PRODUCED BY NONLINEAR INTERACTION OF NONSTATIONARY MAGNETOSONIC WAVES. Daneliya, I. A. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 68-74(1969). (In Russian).

A linearized system of equations which describe a plasma leads to an independent existence of distinct waves in the plasma (superposition of waves). However, consideration of nonlinearity clarifies a whole series of phenomena not appearing in the linear theory. Matter transport by waves is one of these phenomena—the so-called "acoustic wind." The nonlinear interaction of magneto-acoustic waves with a complex frequency and a wave vector is examined here by the method of minor nonlinearities. The introduction of a complex frequency and a wave vector allows for attenuation, as well as an increase in space and time of the interacting magneto-acoustic waves. The theoretical development leads to an equation which shows that a stationary velocity is directed along a k-wave vector of the magneto-acoustic wave, i.e., along the propagation of the wave. Also, the velocity of the diffusion of the plasma is shown to be inversely proportional to first power of the constant magnetic field ("anomalous diffusion"). (K.S.W.)

11056 IMPROVEMENTS IN OR RELATING TO PLASMA CONFINEMENT APPARATUS. Watson, Christopher John Hamilton (to United Kingdom Atomic Energy Authority). British Patent 1,252,762. 10 Nov 1971. Filed 22 May 1968.

The apparatus described comprises a vessel for containing low-pressure gas, means for forming in or introducing into the vessel a plasma, means for producing a static magnetic field tending to confine the plasma, and means for producing an rf electromagnetic field of about 1 MHz that moves relative to the plasma faster than the plasma ions. The means for producing the rf includes an electrical conductor forming an endless path for conducting electrical or electromagnetic power, and having a distributed inductance and capacitance so that it comprises a circuit that resonates at the frequency of the electromagnetic field. Conductors used to localize rf field may comprise subdivided conducting wires. The containment vessel is preferably toroidal, and the endless conducting path preferably comprises a closed toroidal helix surrounding the vessel; a method for forming such a conductor is described. (UK)

11057 PLASMA TRANSPORT IN TOROIDAL CONFINEMENT SYSTEMS. Rosenbluth, M. N. (Inst. for Advanced Study, Princeton, N. J.); Hazeltine, R. D.; Hinton, F. L. Phys. Fluids; 15: No. 1, 116-40(Jan 1972).

The neoclassical theory of plasma transport in axisymmetric, toroidal confinement systems is developed by means of a variational principle for the rate of irreversible entropy production. The variational principle derived here employs the full Fokker–Planck collision operator, including both like- and unlike-species collisions. Using the variational principle, all the relevant neoclassical transport coefficients are systematically evaluated in the "banana" regime of small collisional frequency, to lowest order in the inverse aspect ratio. These results include both the "diagonal" and "cross" coefficients for the particle fluxes, ion and electron heat flux, and electric current. By combining the transport coefficients with appropriate moments of the drift equation, a closed set of equations that accurately summarize the predictions of neoclassical theory in the banana regime is obtained. The significance of these equations, in particular with regard to recent tokamak experiments, is discussed briefly. (auth)

11058 MAGNETOHYDRODYNAMIC EQUILIBRIUM OF AN ELLIPTICAL PLASMA CYLINDER. Gajewski, Ryszard (Massachusetts Inst. of Tech., Cambridge, Mass.). Phys. Fluids; 15: No. 1, 70-4(Jan 1972).

Magnetohydrodynamic equilibrium of an elliptical plasma cylinder is studied for two different current distributions, with longitudinal current either distributed uniformly over the cross section or confined to the surface only. Magnetic surfaces are found analytically in the vacuum around the plasma. They are elongated along the major axis and bound by a separatrix. (auth)

11059 PLASMA HEATING AT THE ELECTRON CYCLOTRON RESONANCE. Vinogradov, N. I.; Podushnikova, K. A.; Poloskin, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 739-42(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 940-3(May 1971).

The conditions under which a group of fast particles is formed in electron cyclotron heating and the heating dynamics of this group and of the main electron component are investigated. It is shown that the efficiency of the heating of the main component and the fast electrons depends on the position of the resonance region in space. The heating rate of the main group is approximately 10^8 eV/sec; the heating rate of the fast particles is approximately 7×10^9 eV/sec. Estimates made show that the heating of the main component can occur outside the resonance region, while the heating of the fast particles occurs in the resonance region. (auth)

11060 POLARIZATION INTERACTION OF PLASMA STREAMS IN A TOROIDAL MAGNETIC FIELD. Korzh, V. G.; Padalka, V. G.; Strashko, A. P.; Tolok, V. T. (Kharkov State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 718-22(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 910-16(May 1971).

Various methods are examined for transverse injection of a plasma into a toroidal magnetic field: injection along the magnetic field gradient, along the major radius of the magnetic system, and polarization interaction of opposing plasma streams in a transverse magnetic field. It is found that polarization interaction of two injected plasmoids greatly increases the total amount of plasma trapped by the magnetic field and reduces the loss of particles in transport along the curved parts of the magnetic system (relative to injection from a single plasma source). The results

confirm the advantages of using polarization interaction of plasma streams in filling a closed magnetic trap. (auth)

11061 TRAPPING OF A MOVING PLASMA IN A TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Khizhnyak, N. A. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 711-17(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 900-9(May 1971).

The kinetics of a plasma flow bounded in the direction of the magnetic field and propagating transverse to the field lines is considered. Field polarization is investigated and the self-induced polarization fields are estimated. Plasma trapping in the direction of the magnetic field due to volume electrostatic separation of polarized charges is discussed. The change in velocity and the amount of trapped plasma as a function of the entrance aperture geometry are investigated experimentally. The results obtained agree qualitatively with the theoretical model. (auth)

11062 TWO METHODS FOR INJECTING PLASMA THROUGH THE DIVERTER IN A STELLARATOR. Atamanov, N. S.; Zalkind, V. M.; Zykov, V. G.; Il'enko, B. P.; Lats'ko, E. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 703-6(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 890-4(May 1971).

Two methods are compared for injecting plasma into closed magnetic traps through the divertor of the Sirius stellarator, which is a system in which a divertor magnetic field is produced briefly. Plasma trapping by the magnetic field of the injector is studied. It is shown that plasma trapping is more efficient when the plasma is injected in the direction of the aperture than for injection tangential to one of the magnetic force lines in the injector. (auth)

11063 PLASMA CONTAINMENT IN A TOROIDAL OCTUPOLE. Molvik, Arthur Warren. Madison, Wis.; Univ. of Wisconsin (1971). 179p. University Microfilms Order No. 71-23,317.

Thesis.

Plasma containment was studied experimentally in a supported-hoop toroidal octupole. Plasma losses were measured by means of electrically biased collectors to be 20 ± 5% to the hoop supports, ≤60% to the hoops, and ≥20% to the walls. The contradiction between MHD theory and octupole experiments is discussed. Several modifications to MHD theory are discussed, some of which result in convective structures qualitatively consistent with observed structures. Another model, dependent upon perturbed field lines spiraling into conducting boundaries, is discussed and seems to be consistent with the data in several respects. Some further theoretical development is also indicated for this model. A number of experiments are suggested to test the various models. (TSS) (Diss. Abstr. Int., B)

11064 EFFECTS OF MAGNETIC FIELD ERRORS AND SHEAR ON PLASMA TRANSPORT TO THE INTERNAL CONDUCTORS OF MULTIPOLE CONTAINMENT DEVICES. Jernigan, Thomas Claude. Madison, Wis.; Univ. of Wisconsin (1971). 184p. University Microfilms Order No. 71-25,477.

Thesis.

The relationship between magnetic field errors and the anomalous particle loss to the interior hoops of toroidal-multipole plasma containment devices was investigated. The response of the particle loss and the plasma structure to the magnitude and symmetry of externally applied errors was studied. External, variable magnetic error coils were attached to two different multipole devices. The plasma current to the internal conductors was monitored as a function of applied error. Probe studies were made of the plasma structure and transient response in perturbed multipole fields. Shear was added to the multipole's poloidal field by means of a toroidal magnetic field. It was concluded that field errors could cause greatly enhanced plasma transport in multipole confinement devices. Shear, added by means of a small toroidal field, was found to be a promising method for reducing the deleterious effects of small field errors. (TSS) (Diss. Abstr. Int., B).

Diagnostics

Refer also to abstract 11191.

11065 (CONF-711012-14) ION SOURCE DIAGNOSTICS METHODS. Poeschel, R. L. (Hughes Research Labs., Malibu, Calif.). [1971]. 36p.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Several methods that have been useful in the development and use of specific discharge-type ion sources are discussed. Diagnostic measurements on ion sources of interest here fall into two categories—those applicable to the ionization chamber and those applicable to the ion beam. The ionization chamber is basically a gaseous plasma and, although numerous plasma diagnostic techniques are appropriate, only those techniques that may be implemented without extensive instrumentation are considered here. Ionization chambers characteristic of the better-known source types are discussed, and diagnostic techniques are correlated as to source characteristics and as to the relative difficulty and productivity of the measurement. Diagnostic techniques for measurement of ion-beam characteristics are independent of ion-source type and consist principally of properly biased current probes and various types of momentum analyzers. Those methods that have been used in development of ion sources at Hughes Research Laboratories in both ion propulsion and ion implantation programs are covered in some detail. (auth)

11066 (MATT-871) SURVEY OF MICROWAVE ELECTRON DENSITY MEASURING SYSTEMS USED IN CONTROLLED FUSION RESEARCH. Ernst, W. P. (Princeton Univ., N. J. Plasma Physics Lab.). Nov 1971. Contract AT(30-1)-1238. 17p. (CONF-711111-21). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A survey of microwave electron-density measuring systems, with a brief introduction to laser-plasma diagnostics, is presented. Resonant cavity techniques, both cylindrical and Fabry-Perot types, are treated. Broad coverage of microwave interferometers is given, indicating the advantages and disadvantages of the various schemes. A summary table is presented to aid the experimentalist in selecting the most appropriate measuring system for the prevailing experimental conditions, i.e., density range of interest, steady-state or transient conditions, large or small plasmas, etc. (auth)

11067 TEMPERATURE PROFILES IN ARGON INDUCTION PLASMAS: THEORY AND EXPERIMENT. Eckert, H. U.; Pridmore-Brown, D. C. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 42: No. 12, 5051-4(Nov 1971).

A comparison is made between recent temperature measurements of argon induction plasmas which include cases of annular geometry and calculations based on the one-dimensional Elenbaas-Heller equation. Exact numerical solutions, as well as approximate closed-form solutions derived from a two-zone model, are used. Good agreement is obtained for the central portion of the plasma column with the exact method for all reported power inputs and with the approximate method for medium-power input. Near the walls, however, the experimental temperatures are considerably higher for all geometries and power inputs. It is argued that here electron diffusion causes an overpopulation of electrons and, thus, an overestimation of gas temperatures when Saha equilibrium is assumed. (auth)

11068 CAPACITIVE-COUPLED PROBE FOR MEASURING POTENTIALS IN A PLASMA. Schmidt, John A.; Kerst, Donald W. (to United States Atomic Energy Commission). U. S. Patent 3,614,606. 19 Oct 1971. Filed 4 Apr 1969.

This capacitive-coupled probe includes an elongated glass tube closed at one end and an electrode mounted within the glass tube at the closed end. A conductor within the tube contacts the electrode and a shield is disposed about the conductor with a dielectric material interposed for insulation purposes. The conductor and electrode are sized with respect to the interior of the tube to restrain relative motion. (auth)

11069 VERIFICATION OF STATIC SPHERICAL PROBE THEORY IN A MOVING HIGH-PRESSURE PLASMA. Clements, R. M. (Univ. of Victoria, British Columbia); MacLatchy, C. S.; Smy, P. R. J. Appl. Phys.; 43: No. 1, 31-7(Jan 1972).

The static high-pressure spherical probe theories of Su and Lam, Cohen, and Kiel were experimentally verified in a flame plasma by moving probes through a flame at the flame velocity and thereby minimizing motional effects. The saturation currents and the current-voltage characteristics at negative voltages show good agreement with the calculated values providing that, at high probe bias levels, a correction is made for the finite residence time of the probe in the plasma. By deliberately introducing a relative velocity between the flame and the probe, the velocity imposed limits of applicability of the probe theory at different voltages were found. For most practical purposes the condition given by Lam that the electric Reynold's number should be <1 is shown to be an adequate criterion for the use of these theories. The implications of these velocity limitations to the results given by previous workers who have used static high-pressure probe theory in moving plasmas are discussed. (auth)

11070 MEASUREMENT OF PLASMA PROPERTIES FROM THE CROSS SPECTRUM OF THERMAL DENSITY FLUCTUATIONS. Geissler, K. H.; Greenwald, R. A.; Calvert, W. (Aeronomy Lab., Boulder, Colo.). Phys. Fluids; 15: No. 1, 96-103 (Jan 1972).

The relation between the density cross-correlation function and the cross spectrum of fluctuations in the electron saturation currents drawn by two Langmuir probes is used to measure basic plasma properties. The measured quantities using this approach are the ambipolar diffusion coefficient and the electron density. It is found that the method has sufficient sensitivity to determine changes in the ionic composition. These measurements are compared with plasma parameters obtained by using conventional probe techniques. Discrepancies are shown to exist and the source of these discrepancies is discussed. (auth)

11071 IZMERENIE RADIOTEPLOVYKH I PLAZMENNYKH IZLUCHENII V SVCH DIAPAZONE. (Measuring Radiothermal and Plasma Radiation in the Microwave Range). Basharinov, A. E.; Tuchkov, L. T.; Polyakov, V. M.; Ananov, N. I. Moscow; Sovetskoe Radio (1968). 391p.

The main electrodynamic and statistical estimates are presented of the spectral and spatial characteristics of radiothermal emissions of gaseous media and media limited to smooth surfaces. Mechanisms of intensity fluctuations of radiothermal emissions are discussed. Methods of measurement of microwave radiation are described, considering the demands of scientific and applied investigations. Four main sections entitled as follows are included: (1) natural background microwave radiation; (2) radiothermal emissions from the Earth mantle and atmosphere; (3) microwave radiation from equilibrium and nonequilibrium plasma; and (4) detection of noise-like signals and data selection. 235 references. (tr-auth)

11072 MEASUREMENT OF ELECTRON DRIFT VELOCITY IN A MAGNETOPLASMA BY MICROWAVE DRAGGING. Gray, R. B.; Makios, V. (Carleton Univ., Ottawa). Phys. Lett.; 37A: No. 4, 359-60(6 Dec 1971).

The measurement of electron drift velocity in a low-pressure gas discharge by a microwave-dragging technique is considered. It is shown that the measurement can be greatly enhanced by the application of an external magnetic field to the discharge. (auth)

11073 MEASUREMENT OF THE VELOCITY OF A PLASMATRON JET BY THE MAGNETOHYDRODYNAMIC METHOD. Levin, A. L.; Khmelinin, B. A. High Temp. (USSR) (Engl. Transl.); 9: No. 2, 373-8(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 413-19(Mar-Apr 1971).

The velocity of a stream of weakly ionized gas from a plasmatron was investigated by means of a magnetohydrodynamic pickup; the data obtained were compared with the results of measuring the velocity by the spectral method and by means of directional probes. The comparison showed that the velocity measured by the magnetohydrodynamic pickup coincides with the ion velocity, and that slip exists between charged and neutral particles. The velocity distributions of the charged particles obtained across the jet issuing from a vacuum volume can be explained by the effect of electromagnetic forces. (auth)

11074 MEASUREMENT OF PLASMA VELOCITY. Il'in, V. M.; Miroshnichenko, A. A. (Inst. of Electrodynamics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 765-9(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 972-8(May 1971).

Inhomogenities in the radiation from a moving, low-temperature plasma (LTP) are investigated, and the possibility of using these for the measurement of LTP velocity is considered. Time-of-flight and VKS (velocity kinescope) results are compared with theoretical values and a method of LTP velocity measurement based on radiation inhomogeneities is indicated. (auth)

11075 MICROWAVE INVESTIGATION OF THE PARAMETERS OF A MICROWAVE DISCHARGE. Belousov, E. V.; Motornenko, A. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 743-8(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 944-51(May 1971).

The properties of the plasma of a microwave discharge are investigated using a microwave-reflection method. The basic principles of the method are described, and quantitative relations are presented for the particle density and frequency of electron collisions with gas atoms. Experimental results obtained with discharges in argon, neon, and helium are presented. A steady-state plasma excited at 3 cm over a wide range of average pressures has a density that exceeds the critical density for the given exciting frequency by one or two orders. The electron temperature in the microwave plasma is determined, using the values of the collision frequency and the corresponding transverse cross sections. Under these experimental conditions the electron temperature in the microwave discharge varies in the same way as in the positive column of a dc discharge and does not change to any great extent when changing from centimeter to meter-wave excitation. (auth)

11076 PLASMA DENSITY IN A COAXIAL INJECTOR WITH SHAPED ELECTRODES. Knyazyatov, A. S.; Kovrov, P. E.; Ladutin, E. G.; Mal'tsev, V. V.; Morozov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 707-10(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 895-9(May 1971).

The tritium-beam method is used to investigate the time variation of the density in a gas jet and in a plasma jet from a plasma injector. The radial density distribution of the jet is observed. The effect of the operating conditions on the parameters of the plasma jet is investigated. It is shown that the density in the plasma jet is an order of magnitude lower than the density in the cold gas stream, being $\sim 10^{15}$ atoms/cm^3 when the flow rate of the working gas (deuterium) is 6 N·cm^3/msec. The density variation in the plasma jet appears with a 100- to 200-μsec delay relative to the beginning of the current pulse in the injector. (auth)

11077 MEASUREMENT OF ELECTRON CONCENTRATIONS IN A DECAYING HELIUM PLASMA. Gerasimov, G. N.; Lyagushchenko, R. I.; Startsev, G. P. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 4, 329-32(Apr 1971).

Translated from Opt. Spektrosk.; 30: No. 4, 606-11(Apr 1971).

A method is proposed for determining the electron concentration n_e in the afterglow of a pulsed gas-discharge plasma. The techniques are used to study the afterglow in helium. The value of the recombination coefficient is determined from the curves for the decay of the electron concentration vs time, using the Grey–Kerr analysis. (auth)

11078 USE OF THE INFRARED CONTINUUM FOR PLASMA DIAGNOSTICS. Preobrazhenskii, N. G.; Sharapova, T. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 6, 541-4(Jun 1971).

Translated from Opt. Spektrosk.; 30: No. 6, 1009-14(Jun 1971).

Calculations are made of the absolute intensity of the bremsstrahlung continuum of a plasma in the 3 to 3×10^3 μ region. The initial parameters are the electron temperature, the electron density, and the dimensions of the plasma layer along the line of sight. They are varied so as to include all experimental conditions that employ infrared diagnostic techniques. The calculations are based on the transport equation for a spatially inhomogeneous plasma and are solved by two different methods. For the cases of a slightly and a highly inhomogeneous plasma, the spectral characteristics of the infrared continuum are analyzed using the most important diagnostic methods. (auth)

11079 IMPROVED PROBE TECHNIQUE FOR PULSED DISCHARGES. Metz, S. (Univ. of Florida, Gainesville). J. Phys., E (London); 4: No. 12, 990-8(Dec 1971).

An improved experimental method is described which permits recording of double probe characteristics of intense pulsed discharges, where the probe system floats momentarily at dangerously high potentials with respect to ground and the sensitive electronic equipment. By complete inductive coupling of the signals to and from the probes and use of a modified sampling technique it is nevertheless possible to trace the current–voltage curves with a recorder. An example of the performance under such severe discharge conditions is given which demonstrates the usefulness and quality of the technique. (auth) (UK)

11080 CHALICE PLASMA TEMPERATURE AS DETERMINED FROM EMITTED RADIATION. Karol, Jerry. Hoboken, N. J.; Stevens Inst. of Tech. (1971). 80p. University Microfilms Order No. 72-1619.

Thesis.

The Chalice electron temperature in the cusp region was determined as $T_e \sim 100$ to 300 eV for at least 5 μsec into the firing event. The temperature was determined by simultaneously measuring the decay time through ionization of the C$_V$ impurity line ($\lambda = 2274$ Å) and the electron density, $n_e \sim 5 \times 10^{16}$ cm^{-3}, with a Mach–Zehnder interferometer. The plasma is held in the cusp for approximately 25 μsec and the temperature is 7 to 8 eV at this later time. Soft x-ray temperature measurements, using an x-ray dual spectrometer, indicated $T_e \sim 70 \pm 30$ eV in the cusp 3 μsec into the firing event. The plasma heating mechanism is dependent on the capacitor-bank charging voltage and the coil geometry. The change from a θ-pinch adiabatic compression to the more-efficient shock-heating mechanism is revealed in the temperature and density measurements. (Diss. Abstr. Int., B)

Kinetics (General)

11081 (UCRL-20815) LIGHT SCATTERING BY ION THERMAL FLUCTUATIONS IN A DENSE PLASMA. Reilly, Dennis A. (California Univ., Berkeley. Lawrence Radiation Lab.). 1 Jun 1971. Contract W-7405-eng-48. 128p. Dep. NTIS.
Thesis.

Laser scattering at 90° is used to obtain a local, detailed mapping in space and time of plasma development in a dense, relatively cold sheet pinch in deuterium gas. The observed plasma scattering parameter, α, covers a range between 0.5 and 2.0 with plasma electron densities between 3×10^{15} to $> 10^{17}/cm^3$, temperatures between 0.5 and 3 eV, and with gross plasma velocities up to 2 cm/μsec. A numerical method for reducing scattering data is presented. Plasma parameters along with expected errors are deduced from each laser shot, with each spectral channel weighted according to its measured statistics and with full account being taken of the finite spectral width of both the laser and the spectrum measuring channels. (M.O.W.)

11082 VARIATIONS IN THE LIGHT EMITTED BY A SEEDED FLAME PLASMA WITH ACOUSTIC WAVE EFFECTS IN THE FLAME. Sinitean, D. D. (Univ., Timisoara, Rumania). Compt. Rend., Ser. B; 273: No. 5, 243-6(2 Aug 1971). (In French).

The experimental results obtained demonstrate that the plasma of a CH_4-O_2 flame seeded with K atoms may be used as an excellent detector of sound waves with a sensitivity greater than that of capacitor-type microphones. (France)

11083 PLASMA PROBLEMS IN ELECTRICAL PROPULSION. Lovberg, Ralph H. (Univ. of California, San Diego, La Jolla). Methods Exp. Phys.; 9: 251-89(1971).

An overall look at the possibilities of electric propulsion by plasmas is presented. The magnetohydrodynamic problems are discussed in some detail. 17 references. (M.O.W.)

11084 ANALYSIS OF THERMAL INDUCTION PLASMAS BETWEEN COAXIAL CYLINDERS. Eckert, H. U. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 43: No. 1, 46-52 (Jan 1972).

A previously derived approximate solution of the one-dimensional energy-balance equation for steady thermal induction plasmas is applied to the case of an annular plasma contained between coaxial cylinders. It is assumed that heat conduction is the only loss mechanism and that both walls are at zero temperature. Charted material is presented to facilitate determination of heat loads to either wall and calculation of temperature distributions across the gap. Results for an atmospheric-pressure argon discharge are compared with both exact numerical calculations and with experimental data. With the former, agreement is fair to good; with the latter it is poor. The disagreement is shown to be caused by electron diffusion, which leads to overpopulation near the walls and suggests erroneously high temperatures when Saha equilibrium is assumed. The experimental temperature profiles are reproduced with excellent accuracy from a diffusion profile for the electrons, which takes into account the nonuniformity of the induced electric field. (auth)

11085 SHOCK WAVES IN COLLISIONLESS PLASMAS. Tidman, D. A.; Krall, N. A. Wiley Series in Plasma Physics. New York; John Wiley and Sons, Inc. (1971). 184p. $10.50.

Detailed discussions are given of the properties of laminar magnetosonic, oblique whistler, and electrostatic shocks. The dissipative role of microturbulence is discussed and some attention is given to the problem of completely turbulent shocks. (M.O.W.)

11086 STUDY OF THE MAGNETOPLASMA REFLECTION IN THE VOIGT CONFIGURATION FOR A NONZERO INCIDENCE ANGLE. Llinares, Claude; Monteil, Eric (Univ., Montpellier, France). Compt. Rend., Ser. B; 272: No. 26, 1485-8(28 Jun 1971). (In French).

A nonzero angle of incidence is required for studying the plasma reflection in a Voigt configuration in a superconducting coil. The effective mass intervening in the magnetoplasma reflection was calculated. Theoretical results were verified experimentally for the case of HgSe at 20°C. (France)

11087 LIGHT PHENOMENA IN INTERACTION OF OPPOSITELY DIRECTED SHOCK WAVES AND A GAS-DISCHARGE PLASMA. Sysun, V. V.; Basov, Yu. G.; Skvortsov, B. V.; Roldugin, V. I. High Temp. (USSR) (Engl. Transl.); 9: No. 2, 230-4(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 257-61(Mar-Apr 1971).

The principle underlying the generation of radiation in the optical range as a result of the interaction of oppositely directed shock waves in a gas-discharge plasma is investigated. It is shown that this principle has a number of advantages over conventional pulsed discharges in a cylindrical tube: the intensity of emission of the plasma increases, the erosion of the electrodes diminishes, and so does the wear on the tubes as a result of the reduction in the mechanical action of the shock waves on the walls; in principle, pulsed high-intensity light sources giving short, high-energy flashes may be created in this manner. (auth)

11088 DESTRUCTION OF PLASMA-GENERATING DIELECTRIC WORKING BODIES IN PULSED PLASMA ACCELERATORS. Davydov, B. B.; Min'ko, L. Ya. (Inst. of Physics, Minsk). Inzh.-Fiz. Zh.; 21: No. 1, 172-5(Jul 1971). (In Russian).

The mechanism of destruction of dielectric insertions (polyfluoroethylene resin) in plasma impactors was studied. Local volumetric behavior of destruction indicates the dominating contribution of radiative heat fluxes. Similarity is found between the processes of polyfluoroethylene resin destruction under the action of pulse discharge and laser radiation. (auth)

11089 INVESTIGATION OF EFFECTS OF A TRANSVERSE MAGNETIC FIELD ON A CONFINED ELECTRIC ARC. Ahrens, Frederick Wheaton. Madison, Wis.; Univ. of Wisconsin (1971). 368p. University Microfilms Order No. 71-25,460.
Thesis.

Several appropriate assumptions were made in this analytical study, e.g., the existence of local thermodynamic equilibrium and that self-magnetic-field effects are negligible. The resulting general arc model is governed by the equations of flow of a viscous, heat-conducting and thermally radiating fluid, including Lorentz-force and Joule-heating terms, together with an integral form of Ohm's law. Three parameters were identified as determining the arc operating characteristics. These are the (dimensional) ratio of arc current to tube radius (I/a), a Reynolds number (Re) based on a characteristic velocity that results from a pairing of Lorentz and viscous forces, and a dimensionless thermal radiation parameter (R_T) representing the relative importance of radiative compared to conduction energy transport. The preliminary approach used yielded explicit mathematical solutions for the two limiting cases of very low and very high Reynolds number. It was necessary to make several idealizations (e.g., use of constant properties) in order to accomplish these solutions. The second, more comprehensive, approach was to use an iterative numerical procedure for solving the general equations, for selected values of I/a, Re, and R_T. Solutions are presented for argon arcs at atmospheric pressure in a tube with 1000°K wall temperature. These runs covered a range of I/a between 10 and 2000 amps/cm. The range of Reynolds numbers corresponded to applied magnetic field strengths between 0 and 500 gauss (assuming an arc of 1/2 cm radius). Cases with and without radiation were examined. The detailed numerical results included the distribution of streamlines and isotherms in the arc cross section, the electric field strength, and the azimuthal distribution of wall heat flux. As a verification of the analysis, a comparison was made with the experimental data of Sauter. In general, the agreement was good. (TSS) (Diss. Abstr. Int., B)

11090 INVESTIGATION OF CHARGED-PARTICLE LOSS PROCESSES IN AN ARC PLASMA. Huang, Kuang-chih. Brooklyn; Polytechnic Inst. of Brooklyn (1971). 105p. University Microfilms Order No. 71-29,061.
Thesis.

The dispersion characteristics of the weak plasma turbulence caused by the electrostatic ion cyclotron instability was investigated. The experimental observations were found to be in good agreement with the predictions of weak turbulent theory. The turbulent diffusion caused by this specific instability in the inhomogeneous, nonisothermal argon arc plasma leads to loss rate of the same order of magnitude as Bohm's anomalous diffusion rate. In the quiescent state, instead, the loss rate follows the classical binary-collision diffusion theory. It is the first time that the direct measurement of the radial loss rate by means of the ring collector technique has been made on the arc-type discharge. The technique is simple and the data are reliable. The indirect measurements of the radial loss rate from both e-folding length measurement and fluctuation measurement are in remarkable agreement with the direct measurement. (Diss. Abstr. Int., B)

11091 RETURN CURRENT INDUCED BY A RELATIVISTIC ELECTRON BEAM PROPAGATING INTO NEUTRAL GAS. McArthur, David A.; Poukey, James W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 27: No. 26, 1765-8(27 Dec 1971).

A model is described for calculating the net current resulting from a 45-kA beam of 3-MeV electrons propagating into neutral nitrogen gas. The model is unique in that it includes the detailed atomic collision processes that determine the return current, and one is able to predict radial, as well as temporal, variations. The results are compared with experiment. (auth)

11092 CONDUCTANCE PEAKS AT THE CYCLOTRON HARMONICS IN A CYLINDRIC PLASMA CAPACITOR. Downward IV, James Germain. Pasadena, Calif.; California Inst. of Tech. (1971). 129p. University Microfilms Order No. 72-471.

Thesis.

A theoretical model is developed and is shown to predict peak height variation with density, harmonic number, and sheath thickness that is in agreement with experimental measurements of the capacitor's complex admittance (susceptance and conductance) and absorption coefficient. A harmonic conduction peak is found to rise initially as density increases, only to fall to a minimum height as the upper-hybrid frequency passes through that harmonic. The noise output of the capacitor is studied and is compared to the theoretical noise output at the harmonics that would be expected for a thermal plasma. The theoretical output is shown to be related to the capacitor's conductance. The capacitor's internal noise oscillations are found to be too intense for a thermal plasma, but the noise peaks at the harmonics show structure and amplitude variation with density in substantial agreement with the theoretical model. To test the validity of the theoretical model, which treats the capacitor's center wire sheath as a vacuum region several Debye lengths thick, the conductance change for small decreases in sheath size is investigated both experimentally and theoretically it is found that the amplitude of the conductance peak within a harmonic passband is very sensitive to small changes in sheath size. This fact leads to a new plasma diagnostic, sheath-modulated transmission. Sheath-modulated transmission experiments are found to enhance cyclotron-harmonic wave effects relative to the amplitude of the transmission peaks at harmonics and to provide information as to the location of the second harmonic band-pass edge. Applications of this work to plasma diagnostics and suggestions for further work are made. (Diss. Abstr. Int., B)

Kinetics (Experimental)

11093 OBSERVATION OF H_β SATELLITES IN THE PRESENCE OF TURBULENT ELECTRIC FIELDS. Gallagher, Charles C.; Levine, Morton A. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev. Lett.; 27: No. 25, 1693-6(20 Dec 1971).

Satellites on either side of the H_β line of hydrogen are reported at a displacement from H_β corresponding to the plasma frequency ω_p and twice such frequency. This anomalous behavior of the H_β transition is correlated with an oscillating electric field associated with plasma turbulence. (auth)

11094 DENSE PLASMA FOCUS. Mather, J. W. (Los Alamos Scientific Lab., N. Mex.). Methods Exp. Phys.; 9: 187-249(1971).

Current plasma focus devices are reviewed. Some plasma diagnostic measurements on a focus discharge are discussed. 65 references. (M.O.W.)

11095 Z PINCH AS A SPECTROSCOPIC SOURCE AND THE INFLUENCE OF SHOCK-PISTON SEPARATION. Roberts, D. E. (Univ. of British Columbia, Vancouver). Phys. Fluids; 15: No. 1, 192-202(Jan 1972).

An experimental study was made of the peak compression phase of the linear (z) pinch in argon as a spectroscopic source. The initial pressure of argon was varied from 0.05 to 1 torr and the condenser bank energy from 0.12 to 3.1 kJ. Over this range of conditions measurements of the plasma refractive index yielded quantitative values of electron density in the range 10^{16} to 2×10^{18} cm^{-3}. The electron temperature was found to be between 2 and 3 eV. It was found that complete local thermal equilibrium could not be attained with low energy inputs, irrespective of the initial filling pressure, but that for a bank energy $\gtrsim$2 kJ local thermal equilibrium should be a good approximation. At high pressures the pinching of the discharge was found to be inhibited so that the axial electron density peaked at some critical pressure. A model based on current penetration into the shock piston region was able to explain the behavior of the observed radial distribution of electron density at different pressures as well as the scaling properties of the critical pressure. Other measurements pertaining to this phenomenon are also examined. Finally, it was found that a large degree of shock-piston separation occurred at high filling pressures but not at low pressures contrary to the "skin depth criterion." (auth)

11096 PLASMA MAGNETIC MOMENT INDUCED BY AN ULTRA-HIGH-FREQUENCY FIELD. Lobov, G. D.; Shtykov, V. V. (Moscow Power Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 956-7(1971). (In Russian).

Observation of the magnetic moment induced by an ultrahigh-frequency field has been made previously for a plasma located in a constant magnetic field. Apparatus is described for experimentally observing the magnetization of a plasma under the influence of uhf vibrations with circular polarization. Good agreement was observed between theoretical and experimental dependence of the coil voltage on the deflection angle of the polarizer. (K.S.W.)

11097 EXPERIMENTAL INVESTIGATION OF A CONTINUOUS OPTICAL DISCHARGE. Generalov, N. A.; Zimakov, V. P.; Kozlov, G. I.; Masyukov, V. A.; Raizer, Yu. P. (Inst of Mechanical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1434-46(Oct 1971). (In Russian).

The results of an investigation of the continuous optical discharge are presented. The limits of its existence and also the shape and size as depending on light intensity and gas pressure are studied. The fraction of light beam energy absorbed in the discharge is determined. The electron density is found, and an estimate of plasma temperature is given on the basis of broadening of the hydrogen H_β line. (auth)

11098 SOME CHARACTERISTICS OF THE DISCHARGE IN THE INDUCED ELECTRIC FIELD BEHIND A SHOCK WAVE IN ARGON. Maksimov, A. M.; Nikuev, Yu. A. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 210-14(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 236-9(Mar-Apr 1971).

A discharge between cold electrodes in an induced electric field for a supersonic flow of an argon plasma in a transverse magnetic field was studied. The breakdown voltage in an induced field is higher than that for a field from an external source, which agrees well with the theory that incorporates the reduced electron mobility in a transverse magnetic field if $\omega\tau$ is calculated for the conditions at the surface of an electrode. There is a substantial increase in conductivity if the Joule heating is sufficient to produce nonequilibrium ionization. The supersonic flow displaces the arc in the induced field in the flow direction, and there is periodic breakdown along the chord of the elongated arc under certain conditions. This effect results in conductivity inhomogeneity in the generator channel. (auth)

11099 INTENSE RELATIVISTIC ELECTRON-BEAM PROPAGATION IN PREIONIZED GAS. Benford, James; Ecker, Bruce (Physics International Co., San Leandro, Calif.). Phys. Fluids; 15: No. 2, 366-7(Feb 1972).

An experiment is described that demonstrates that high-current relativistic electron beams that contain substantial transverse electron motion expand rapidly when injected into field-free preionized gas. (auth)

11100 ENERGY DISTRIBUTION OF ELECTRONS IN MOVING STRIATIONS. Bessonova, K. F.; Oreshak, O. N.; Ostapchenko, E. P.; Stepanov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 770-4(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 979-84(May 1971).

The potential, density, average energy, and energy distribution of electrons in moving striations were studied in the inert gases neon, argon, krypton, and xenon, and in mixtures of mercury and helium with inert gases. The energy distributions of electrons in stationary and moving striations are compared. (auth)

11101 ELECTROMAGNETIC RADIATION AT THE ONSET OF AN INSTABILITY OF A PLASMA IN A MAGNETIC TRAP. Babichev, A. P.; Karchevskii, A. I.; Muromkin, Yu. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 737-8(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 937-9(May 1971).

Characteristics of the electromagnetic radiation at the onset of an instability of a plasma with hot electrons confined in a mirror system were studied. Intensity maxima were found near frequencies $\omega = 0.85n\omega_{He}$, where n = 1, 2, 3, 4, 5, and ω_{He} is the electron cyclotron frequency corresponding to the magnetic field at the axis in the central plane. (auth)

11102 ION ACCELERATION IN A CURRENT-CARRYING PLASMA. Mkheidze, G. P.; Plyutto, A. A.; Korop, E. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 749-57(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 952-62(May 1971).

Ion acceleration in a current-carrying plasma in a narrow gap (10 to 50 mm) was investigated. The maximum energy acquired by the accelerated electrons is 35 to 60 eU_0 (U_0 being the initial [accelerating] voltage). It is shown that acceleration occurs in the current-carrying plasma when a critical value of the current is reached. This critical value depends on the plasma density in the gap and on the saturation current. The spatial distribution and the energy spectrum of the accelerated ions were measured. The angular dispersion of the ion burst is 3 to 6° and the energy spread $\Delta W/W \simeq 0.2$. The perturbation of the electron beam density (the perturbation being defined as the amount of radial electron flux) depends on the ion burst. The current density of the electron beam in the region near the axis increases up to values of 10^4 A/cm² in the acceleration process, while the ion acceleration begins when the primary current reaches its peak. The current of the accelerated ions increases up to several amperes in pulses lasting $\sim 10^{-7}$ sec. (auth)

11103 ION FLOW IN A DOUBLE-LENS ACCELERATOR. Zubkov, I. P.; Kislov, A. Ya.; Morozov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 695-702(Nov 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 5, 880-9(May 1971).

The spatial distribution of the ion flow produced by a high-current plasma accelerator is determined. The energy spectra and mass composition of the particle stream from the accelerator are measured at various angles. The experimental results are compared with theory. (auth)

11104 PRODUCTION OF INTENSE ELECTRON BEAMS BY CURRENT FLOW THROUGH A PLASMA. Mkheidze, G. P.; Korop, E. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 690-4(Nov 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 5, 873-9(May 1971).

The production of an intense pulsed-electron beam by current flow through a narrow gap (10 to 30 mm) filled with plasma was investigated. The beam current is 4 kA. The current density in the paraxial beam region is of order 10^4 A/cm². The pulse length is (2 to 5) $\times 10^{-8}$ sec. The electron energy $W \gtrsim eU_0$, where $U_0 \approx 30$ to 40 kV is the initial voltage on the condenser that provides the current in the plasma. Transfer of the region of localization of the electric field from anode to cathode explains the observed phenomena qualitatively. (auth)

11105 LUMINESCENCE FLARE-UP AND POPULATION OF CESIUM LEVELS DURING THE DECAY OF A HELIUM–CESIUM DISCHARGE PLASMA. Morgulis, N. D.; Polushkin, I. N.; Kravchenko, A. I.; Kogan, E. Ya.; Fisun, O. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 4, 325-9(Apr 1971).
Translated from Opt. Spektrosk.; 30: No. 4, 597-605(Apr 1971).

A detailed investigation is made of the flare-up of cesium spectral lines during the decay of a helium–cesium discharge plasma. It is shown that there is a very marked difference in the character of luminescence in P → S and S → P → S channels on one hand and D → P → S and F → D → P → S channels on the other. The variation in the concentration of excited cesium atoms during decay of the plasma is determined. The possibility of population inversion of the D levels relative to the 7P level is observed. A theoretical interpretation is given for some of the phenomena observed. (auth)

11106 EXPERIMENTAL INVESTIGATION OF A COAXIAL PLASMA ACCELERATOR IN STEADY TURBULENT FLOW. Stringfellow, David Orvis. Hoboken, N. J.; Stevens Inst. of Tech. (1971). 117p. University Microfilms Order No. 72-1633.
Thesis.

An experiment was performed under conditions such that the plasma flow was turbulent outside the accelerator. The results obtained indicate that: (1) The mean magnetic flux per unit mass of plasma in the turbulent flow outside the accelerator was related to that in the nonturbulent flow inside the accelerator by the equation for frozen magnetic flux. Thus the assumption of frozen magnetic flux is valid when the flow is turbulent. (2) Self-compression of the low-β plasma did not occur when the flow outside the accelerator was turbulent, but did occur when the flow was nonturbulent. (3) The mean energy per unit mass of plasma in the turbulent flow outside the accelerator was as much as a factor of 25 less than that in the nonturbulent flow inside the accelerator, whereas when this accelerator was operated under conditions such that the flow outside the accelerator was nonturbulent, the mean energy per unit mass was only approximately a factor of two less than that inside the accelerator. (4) There is a correlation between the mean energy per unit mass in the turbulent flow and the relative amplitude of the magnetic field fluctuations. (TSS) (Diss. Abstr. Int., B)

11107 COMBINATION OF INTENSE RELATIVISTIC ELECTRON BEAMS IN A Z PINCH. Benford, James; Ecker, Bruce (Physics International Co., San Leandro, Calif.). Phys. Rev. Lett.; 28: No. 1, 10-13(3 Jan 1972).

Two intense relativistic electron beams were combined while propagating within the collapsing current sheet of a z pinch. Appropriate choice of the time of injection of the beams into the pinch gave high transport efficiency as well as beam mixing. (auth)

11108 OBSERVATION OF RESONANCE SCATTERING ON EXCITED HELIUM ATOMS IN A PLASMA USING A TUNABLE DYE LASER. Burrell, C. F.; Kunze, H.-J. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 28: No. 1, 1-4(3 Jan 1972).

Resonance scattering on excited helium atoms is observed by focusing a tunable dye laser at 4471 Å into a cold plasma of a low degree of ionization. Scattering signals due to collisional excitation transfer and radiative decay are observed on many other lines. The magnitude and the pulse shape of the scattered signals are discussed in terms of collisional and radiative transfer rates; a few collisional rates could be deduced. (auth)

Kinetics (Theroretical)

Refer also to abstracts 10367 and 11006.

11109 (INR-P-1335) COMMENTS ON POPULATION DENSITIES AND IONIZATION EQUILIBRIUM IN TWO-TEMPERATURE PLASMA. Suckewer, Szymon; Skorupski, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1971. 4p. Dep. NTIS (U. S. Sales Only).

Reasons for the discrepancies between earlier results concerning population densities and ionization equilibrium in a hydrogen plasma are discussed. An analytic formula for population densities, valid also in nonequilibrium situations, is given. (auth)

11110 KUBO CONDUCTIVITY OF A STRONGLY MAGNETIZED TWO-DIMENSIONAL PLASMA. Montgomery, David; Tappert, Frederick (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett.; 27: No. 21, 1419-21(22 Nov 1971). [22]

The Kubo formula is used to evaluate the bulk electrical conductivity of a two-dimensional guiding-center plasma in a strong dc magnetic field. The particles interact only electrostatically. An "anomalous" electrical conductivity is derived for this system, which parallels a recent result of Taylor and McNamara for the coefficient of spatial diffusion. (auth)

11111 RELATIONSHIP BETWEEN THE CRITICAL VALUE OF MAGNETIC FIELD INTENSITY AND PRESSURE IN THE POSITIVE COLUMN OF A DISCHARGE. Kubarev, Yu. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 79-85(1969). (In Russian).

The formation and motion of plasma in magnetic and electric fields are chiefly determined by the diffusion of charged particles. The diffusion coefficient, the effect of a critical magnetic field, the application of a hydrodynamic approximation, and azimuthal and radial diffusion of ions and electrons are discussed from the viewpoint of various authors. Theoretical and experimental data are reviewed and compared. 17 references. (K.S.W.)

11112 MAGNETIC THERMAL INSULATION OF A PLASMA PRODUCED IN THE PASSAGE OF AN ELECTRON FLOW THROUGH A RAREFIED GAS. Anastasevich, V. S. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 54-6(1969). (In Russian).

The starting point in this mathematical development is a set of equations, partially derived from Maxwell and recorded in a hydrodynamic approximation, which represents a cylindrical electron beam at equilibrium. The equation finally obtained shows that for a sufficiently high plasma density, formed into a beam, it makes no sense to talk about magnetic thermal insulation, since this plasma extends an unlimited distance from the beam. A current of secondary particles on the chamber walls is determined not by the velocity of diffusion of the secondary particles, but by the conditions of stationarity, i.e., by an equivalence of a current of secondary particles newly forming secondary particles in the beam and surrounding the plasma beam. (K.S.W.)

11113 COMPUTER STUDY OF CONVECTION OF WEAKLY IONIZED PLASMA IN A NONUNIFORM MAGNETIC FIELD. Shiau, Jeng-nan (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids; 15: No. 1, 183-91(Jan 1972).

A weakly ionized plasma in a strong and nonuniform magnetic

field exhibits an instability analogous to the flute instability in a fully ionized plasma. The instability sets in at a critical magnetic field. To study the final state of the plasma after the onset of the instability, the plasma equations are integrated numerically assuming a certain initial spectrum of small disturbances. In the regime studied, numerical results indicate a final steadily oscillating state consisting of a single finite amplitude mode together with a time-independent modification of the original equilibrium. These results agree with the analytic results obtained by Simon in the slightly supercritical regime. As the magnetic field is increased further, the wavelength of the final oscillation becomes nonunique. There exists a subinterval in the unstable wave band. Final stable oscillation with a wavelength in this subinterval can be established if the initial disturbance has a sufficiently strong component at the particular wavelength. (auth)

11114 TWO-FLUID THEORY OF THE POSITIVE COLUMN OF A GAS DISCHARGE. Ingold, J. H. (General Electric Co., Cleveland). Phys. Fluids; 15: No. 1, 75-85(Jan 1972).

The transition from inertia-limited flow to mobility-limited flow of ions to the walls of the positive column of a planar gas discharge is analyzed from a hydrodynamic point of view. The analysis is based on the assumption that the electrons and ions in the positive column behave as inviscid fluids with different temperatures. The resultant formulation is valid for gas pressures from the free-fall limit to the continuum limit, including the high-field sheaths at the walls as well as the almost field-free plasma at the center of the discharge. Numerical results for the characteristic value, wall field, wall potential, and ion energy at the wall are given for many different pressures and central Debye lengths, and it is shown that the results are identical to those of Allis and Rose in the continuum limit and very close to those of Self in the free-fall limit. (auth)

11115 LORENTZ PLASMA IN A STRONG MAGNETIC FIELD. Radin, S. (Lehigh Univ., Bethlehem, Pa.). Phys. Fluids; 15: No. 1, 91-5(Jan 1972).

The electron distribution function was calculated for a Lorentz plasma in a strong arbitrarily oriented magnetic field and in a weak electric field, temperature gradient, and flow-velocity gradient. The magnetic field is strong enough to significantly affect the collision process, but it is not so strong that it completely dominates the plasma. Using the electron distribution function, corrections to the usual thermoelectric transport coefficients and viscosities were calculated. The corrections are zero, to this order in the magnetic field, for the electrical and thermal conductivities and the thermoelectric coefficients and are typically on the order of 1% or less for the longitudinal, transverse, and Hall viscosities. (auth)

11116 LINEARIZED VARIATIONAL ANALYSIS OF SINGLE-SPECIES, ONE-DIMENSIONAL VLASOV PLASMAS. Lewis, H. Ralph (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 15: No. 1, 103-15(Jan 1972).

Analysis of linearized Vlasov plasmas by means of Hamilton's variational principle is illustrated by application to the initial-value problem for a neutralized, single-species plasma in one-spatial dimension with periodic boundary conditions. For any degree of approximation and for arbitrary equilibrium velocity distributions, the problem is reduced to the solution of a system of ordinary differential equations in time with constant coefficients and time-dependent driving terms; an exact particular solution was found. The equations are discussed, including the relation of the equations to Eulerian treatments of the problem, and the use of the equations to obtain numerical results. Numerical examples are worked out for a Maxwellian equilibrium distribution function, equilibrium distribution functions that are sums of two Maxwellian distributions, and for nonanalytic equilibrium distribution functions that are represented by cubic spline functions. Comparisons are made between numerical results from the variational method and precise solutions of the exact plasma dispersion relation. (auth)

11117 PROBABILITY DISTRIBUTION FOR A BEAM IN A MEDIUM WITH RANDOM INHOMOGENITIES. Tatarskii, V. I. (Inst. of Atmospheric Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 960-2(1971). (In Russian).

During the furthermost propagation of a beam in a nonhomogeneous medium there will occur the utmost fluctuation of direction of the beam's propagation, and the law of distribution of probabilities should tend toward the isotropic. This extreme case of evolution of the law of distribution is impossible to describe using the Einstein–Fokker equation, and an alternate approach is made in order to obtain a precise solution to this problem. (K.S.W.)

11118 PONDEROMOTIVE FORCES IN INTERACTION OF LASER RADIATION WITH A PLASMA. Green, B. J.; Mulser, P. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 37A: No. 4, 319-20(6 Dec 1971).

Previous estimates of the nonlinear ponderomotive forces that arise in the interaction of intense laser light with plasma indicate that they can dominate the plasma expansion. A model problem is described numerically and the shortcomings of former approximate investigations are shown. (auth)

11119 KINETIC THEORY OF A TWO-DIMENSIONAL MAGNETIZED PLASMA. Vahala, George; Montgomery, David (Univ. of Iowa, Iowa City). J. Plasma Phys.; 6: 425-39(Oct 1971).

Several features of the equilibrium and nonequilibrium statistical mechanics of a two-dimensional plasma in a uniform dc magnetic field are investigated. The problem is considered both with and without the guiding-centre approximation. With the guiding-centre approximation, an appropriate Liouville equation and BBGKY hierarchy predict no approach to thermal equilibrium for the spatially uniform case. For the spatially nonuniform situation, a guiding-centre "Vlasov" equation is discussed, and is solved in special cases. (auth)

11120 E-LAYER PRECESSION IN A PLASMA. Berk, H. L.; Sudan, R. N. (International Centre for Theoretical Physics, Trieste, Italy). J. Plasma Phys.; 6: 413-24(Oct 1971).

A weak E layer in a nonuniform magnetic field will tend to precess as a rigid body in response to the radial focusing of external magnetic fields and fields due to wall currents. The interaction of this precessional mode with a background plasma is studied, and dissipation mechanisms in the plasma, walls, and external resistors are included. When the plasma background is treated in the MHD approximation, it is found that the mode changes character from a precessional mode at low density to a compressional Alfvén wave at high density. For a very weak E layer, instability is found, even without dissipation, when a sufficiently high-background plasma density is present. However, for moderate E-layer strengths, the modes are found to be stable, even with dissipation. (auth)

11121 CYCLOTRON RADIATION IN HOT MAGNETOPLASMAS. Trulsen, Jan (Univ. of California, San Diego). J. Plasma Phys.; 6: 367-400(Oct 1971).

The effects of thermal motions on the cyclotron radiation from test particles gyrating in a homogeneous magnetoplasma are studied. These effects take care of all singularities that exist in the theory of cyclotron radiation in cold magnetoplasma, e.g., the divergence in energy loss for small particle energies. Around the hybrid frequencies thermal corrections become of dominant importance. At these frequencies cold-plasma theory breaks down. Thermal effects arise in two ways: by modifying the wave modes known from cold plasma theory and by the introduction of a new longitudinal wave mode, known as the Bernstein mode. All wave modes are damped (in stable plasmas), the damping increasing rapidly with the product $(V/v_{||})(\omega - s)$, where the wave frequency ω is measured in units of the gyro frequency; V is the thermal velocity, $v_{||}$ the parallel component of the particle velocity, and s is an integer. (auth)

11122 SIMILARITY SOLUTIONS IN MAGNETOHYDRODYNAMICS. Sozou, C. (Univ. of Sheffield, Eng.). J. Plasma Phys.; 6: 331-41(Oct 1971).

Similarity considerations are employed to investigate the flow field produced by an electric discharge (mathematically a current source) and a jet of momentum emerging from the same hole of a plane wall bounding a viscous, incompressible conducting fluid, which extends to infinity. Similarity solutions are also used in considering the axisymmetric configuration of a problem that has recently received some attention in connection with field line reconnection in conducting fluids. The similarity equations for an incompressible, viscous conducting fluid are derived, and the solutions for the case when the fluid is perfectly conducting are discussed. (auth)

11123 SINGULAR PERTURBATION ANALYSIS OF THEORETICAL MODELS FOR WARM INHOMOGENEOUS PLASMAS. Miura, Robert M.; Barston, Eugene M. (New York Univ., N. Y.) J. Plasma Phys.; 6: 271-82(Oct 1971).

Owing to the complexity of the Vlasov–Maxwell equations for inhomogeneous plasmas, it is of general interest to investigate simpler approximate models. Three specific models, proposed in the literature in connection with the high-frequency oscillations of such plasmas, are compared by means of a singular perturbation expansion in powers of $\epsilon = (\lambda_D/L)^{\frac{1}{3}}$, where λ_D and L are appropriate electron Debye and equilibrium scale lengths, respectively. Explicit formulas are obtained for the eigenfrequencies (to second order) and for the electric field eigenfunctions (to

leading order), and the computation of these quantities for various equilibrium parameters becomes very simple indeed. It is found that, whereas the electric field eigenfunctions differ in zero order for the three models, the eigenfrequencies are identical through first order. (auth)

11124 POLARIZATION LOSSES OF A FAST HEAVY PARTICLE IN A PLASMA LOCATED IN A STRONG HIGH FREQUENCY FIELD. Aliev, Yu. M.; Gorbunov, L. M.; Ramazashvili, R. R. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1477-80(Oct 1971). (In Russian).

Polarization losses of a charged particle passing through a plasma in a homogeneous high-frequency electric field are considered. It is shown that due to alteration of the plasma dispersion in the uhf field, conditions are created that lead to a strong increase of the particle losses. (auth)

11125 THEORETICAL STUDY OF QUASI-STATIC LINEAR THETA PINCH. I. Badr, Omar (Assiut Univ., Egypt). J. Natur. Sci. Math.; 10: No. 2, 275-85(Oct 1970).

Starting from the two-fluid model of plasma, one can regard the static equilibrium as a state in which the ion and electron gases are flowing in opposite directions with equal momenta. Neglecting the average motion of the ions relative to the electrons, the plasma can be regarded in quasi-static equilibrium and one can apply the ordinary magnetohydrostatics equations. The condition of such an approximation is found to be: $(1 + T_i/ZT_e)^{\frac{1}{2}} \cdot r_g/a < 1$, where Z is the atomic number, a is the radius of the plasma, r_g the radius of gyration of the electron in a constant magnetic field of strength equal to the value of the magnetic induction along the axis, and T_i (T_e) is the ion (electron) temperature. Using this model, the average velocity distribution is calculated in ordinary and hard-core linear theta pinches and a pinch relation is obtained. The confinement of plasma is considered. Also, two regions of equilibrium are found: (i) $\beta < 1$ and (ii) $\beta > 1$; β is the ratio of the kinetic pressure of the plasma to the external magnetic pressure. (auth)

11126 THEORY OF PHASE SPACE DENSITY GRANULATION PLASMA. Dupree, Thomas H. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 15: No. 2, 334-44(Feb 1972).

A novel state of turbulent plasma characterized by small-scale phase-space granulations called "clumps" is proposed. Clumps are produced when regions of different phase-space density are mixed by the fluctuating electric field. They move along ballistic orbits and drive the turbulent field in a manner similar to that in which thermal fluctuations are driven by particle discreteness. In the coherent wave limit the clumps become the familiar trapped-particle eddies of a Bernstein–Green–Kruskal mode. The turbulent state can exist in the absence of linear instability, although it is more likely to occur in a linearly unstable plasma. The spectrum contains a ballistic portion as well as resonances at the wave (collective) frequencies. The discreteness of the clumps produces collision-like process. For example, the average distribution function satisfies a Fokker–Planck equation instead of a quasi-linear diffusion equation. (auth)

11127 LINEAR TIME-DEPENDENT VLASOV EQUATION; CASE–VAN KAMPEN MODES. Bateman, Glenn (New York Univ., N. Y.); Kruskal, Martin D. Phys. Fluids; 15: No. 2, 277-83(Feb 1972).

The multiple-time-scale method is used to find a succinct solution for the linearized Vlasov equation when the background state of the plasma is a slowly varying function of time. It is found to be necessary to consider normal modes of the equation because the slow and fast time variables synchronize separately for each mode. The asymptotic series for each normal mode and for its associated frequency are computed to all orders in the expansion parameter. The lowest-order results are the Case–Van Kampen modes in WKB form. The corrections represent a diagonalization of the results of Baldwin, Trocheris, and Imre. In particular, the dispersion function is corrected by higher-order terms and the frequencies of the discrete spectrum have complex-valued shifts. (auth)

11128 INTEGRABILITY OF THE MAGNETOHYDRODYNAMIC EQUATIONS FOR ROTATIONAL SYMMETRIC CONFIGURATION OF PLASMA WITH INFINITE CONDUCTIVITY. Badr, O. (Assiut Univ., Egypt). Phys. Fluids; 15: No. 2, 364-5(Feb 1972).

The integrability condition for the magnetohydrodynamic equations for rotational symmetric stationary plasma with infinite conductivity is obtained. It is found that the total enthalpy is conserved on a magnetic surface. Using this condition, a geometrical representation of the flow (sub- and supersonic) is given. (auth)

11129 PLASMA CONDUCTIVITY IN A STRONG ELECTROMAGNETIC FIELD. Fedorov, M. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 671-7(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 849-56(May 1971).

The propagation of an electromagnetic wave through a plasma in a strong electromagnetic field is discussed. It is shown that the plasma conductivity at frequencies other than the frequency of the external field is different from that in the equilibrium case. General expressions and asymptotic expressions are obtained for the plasma conductivity in the case of a strong external field. At high external fields a number of Raman scattering components appear. Equations are derived for the scattered light intensity for arbitrary external fields. (auth)

11130 ION TRANSIT TIME EFFECTS IN THE PLASMA SHEATH. Rosa, R. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). J. Phys., A (London); 4: No. 6, 934-43(Nov 1971).

The equation of motion of the ions in an ion-rich plasma sheath as well as the appropriate initial conditions that hold for all frequencies well below the electron plasma frequency are obtained. The problem of ion motion in the case when a small amplitude rf voltage is applied to the sheath is solved. One thus obtains the sheath admittance as a function of the plasma parameters, the applied dc voltage and frequency. One reaches the conclusion that, besides the electron contribution, there also exists an ion contribution to the sheath conductance and that the sheath susceptance, although dominated by a capacitive term, cannot be wholly ascribed to this one alone. Simple equivalent circuits are proposed to represent the plasma sheath in the low and in the high frequency limits. The sheath admittance was computed over the frequency range in which the ion transit time effects are relevant. Finally, the advantage in employing the rf probe technique near the ion plasma frequency is pointed out. (auth)

11131 THERMOCHEMICAL NONEQUILIBRIUM IN AN ARGON CONSTRICTED-ARC PLASMA. Clark, Kimble John. Lafayette, Ind.; Purdue Univ. (1971). 544p. University Microfilms Order No. 72-1843.

Thesis.

Results of a theoretical investigation of thermochemical nonequilibrium in a three-component, confined, argon arc plasma are presented. Multifluid models comprised of species and global conservation equations are developed to account for nonequipartition of species thermal energy and chemical nonequilibrium effects. All significant nonequilibrium transport phenomena and all microscopic processes which significantly affect the plasma composition and volumetric energy transfer are included in the conservation equations. A nonequilibrium electrostatic sheath model is used to provide the wall boundary conditions for the electron subgas. An explicit, finite-difference technique, based upon the numerical scheme of DuFort and Frankel, is developed to provide solutions to the coupled, nonlinear, second-order, partial differential equations representing the entrance region of the arc. In addition, the ordinary differential equations representing the fully developed region are solved using a finite-difference matrix iteration scheme. The solutions to the governing equations reveal that a thermochemical nonequilibrium condition always exists near the duct wall. This condition is characterized by an electron temperature several times greater than the heavy-particle temperature and a nonequilibrium electron number density orders of magnitude greater than the corresponding equilibrium value. Furthermore, the relative radial location of the departure from local thermodynamic equilibrium is found to shift toward the arc core with decreasing arc current, decreasing pressure, or increasing duct radius. Critical comparisons of the theoretical predictions with available experimental measurements for the fully developed region are presented for arc currents of 35 to 400 amperes, a pressure of one atmosphere, and a duct diameter of one centimeter. Generally, the predictions agree with the measurements to within the corresponding experimental uncertainties: total wall heat transfer (±6%), radiative wall heat transfer (±10%), axial electric field intensity (±3%), and electron temperature (±2.5%). (Diss. Abstr. Int., B)

11132 HELICAL EQUILIBRIUM OF A CURRENT-CARRYING PLASMA. Yoshikawa, S. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett.; 27: No. 26, 1772-4(27 Dec 1971).

By means of magnetohydrodynamic approximations, helical equilibrium configurations of current-carrying plasmas housed in a perfectly conducting cylinder were obtained. A particular solution with twisting current channels was obtained at finite amplitude. A small-amplitude equilibrium equation for arbitrary

current distributions was also obtained. The presence of magnetic islands in the equilibrium configurations is apparent. (auth)

11133 ANALOGY BETWEEN TURBULENT TRANSFER IN VELOCITY SPACE AND PLASMA COLLISIONAL TRANSPORT IN REAL SPACE. Coppi, B. (Massachusetts Inst. of Tech., Cambridge); Santini, F. Phys. Rev. Lett.; 28: No. 1, 19-21 (3 Jan 1972).

Plasma transport across a magnetic field due to ion–ion collisions is related to a model for transport of momentum in velocity space in the presence of plasma fluctuations of small amplitudes. A model of this kind, relying on the trapping of particles in plasma waves, may be proposed as an explanation of the observed lack of runaway electrons in confined plasmas on which relatively strong electric fields are applied. (auth)

11134 STARK PROFILES OF FORBIDDEN COMPOUNDS. Griem, H. R. (Univ. of Maryland, College Park). Comments At. Mol. Phys.; 2: No. 6, 206-10(Feb-Mar 1971).

It is stated that, in He plasmas, diffuse He lines (2P–nD) are often accompanied by forbidden components (2P–nF) since the presence of electric microfields leads to a breakdown of the usual selection rules. Profiles of such lines calculated recently, using the quasi-static approximation for ions and the impact approximation for electrons and neglecting nonequilibrium collective effects, were found to deviate from calculations somewhat more than was expected from experience with other neutral-atom lines, particularly in measurements at low electron densities. It had been suggested that these deviations are caused by a breakdown of the quasi-static approximation for the perturbing ions; it is suggested here that the corresponding corrections can be estimated from a small extension of the familiar classical-path second-order dipole interaction theory of impact broadening. The importance of dynamical corrections, especially at low densities and high temperatures, was confirmed; there seems to be no need for additional corrections. Inelastic collisions are entirely dominant in the time-dependent semiclassical theory outline, and the classical path approximation should be very accurate for perturbing ions. More serious restrictions on the theoretical model discussed are the neglect of overlap in time between different collisions, and the use of second-order perturbation theory, which does not describe the transition to linear Stark effect. (13 references) (UK)

Production

11135 (CEA-N–1470) HYDRODYNAMIC DESCRIPTION OF A PLASMA SUBJECTED TO A MAGNETIC FIELD: THE GRANULE LASER PROBLEM. Bayard, Jean-Paul; Boujot, Jean-Paul; Soule, Jean-Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 61p. (In French). Dep. NTIS (U. S. Sales Only).

An attempt is made to simulate a real physical experiment: the problem of the spatio-temporal evolution in a magnetic field of a plasma obtained by the total ionization of a H–Li granule under the action of a laser beam. The mathematical model involves the hydrodynamic description of the plasma and the MHD equations deduced from this description (BBKGY system). (France)

11136 (UCRL–73500) SOME ASPECTS OF CONTROLLED FUSION BY USE OF LASERS. Kidder, Ray E. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Oct 1971. 20p. (CONF-710826–1). Dep. NTIS.

From Symposium on fundamental and applied laser physics; Isfahan, Iran (29 Aug 1971).

The application of lasers to controlled fusion is considered, particular attention being given to fusion reactors based on laser-heated DT pellets. The requirements a laser must meet to be useful for this purpose are discussed. A decoupling effect resulting from the fact that long-wavelength light can only penetrate and heat plasma electrons at relatively low density is described, which suggests that light of wavelength as great as ten microns may not be suitable for pellet heating. (auth)

11137 ACCELERATION OF A SUPERCONDUCTING MACROPARTICLE IN A MAGNETIC TRAVELING-WAVE ACCELERATOR. Anderson, D.; Claflin, S.; Winterberg, F. (Univ. of Nevada, Las Vegas. Univ. of Nevada, Reno). Z. Naturforsch.; 26a: No. 9, 1415-24(Sep 1971).

Two models for describing the operation of a magnetic traveling-wave accelerator, the transmission line model and the lumped parameter model, are analyzed. For both cases the current distribution and the magnetic field are calculated. It is shown that the transmission-line model can be obtained as the limiting case of the lumped parameter model. It is then assumed that a superconducting solenoid with large persistent currents is used as a projectile with a constant magnetic dipole moment. The motion of this projectile is studied in the case of ignorable flux interaction. The conditions for phase and rotational stability are obtained. It is shown that the projectile has a transverse translational instability. A derivation of the flux interaction current wave is included in the Appendix. (auth)

11138 PRECURSOR IONIZATION FRONTS AHEAD OF EXPANDING LASER PLASMAS. Koopman, David W. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 1, 56-62(Jan 1972).

Fast ionization fronts were experimentally observed to propagate ahead of a laser-produced plasma expanding into low-density background gas. The ionizing wave has a velocity of 0.3 to 3×10^8 cm/sec and a thickness of 1 to 10 cm, both quantities increasing with radius of propagation. Langmuir probe and microwave diagnostics indicate that the wave augments the initial photoionization density by a factor of ~3; potential fluctuations exist within the wave that can accelerate electrons to energies above the ionization threshold. Equations describing a collisional ionizing electron wave are solved in an approximate manner to yield relations that agree with many features of the measured phenomena. (auth)

11139 CALCULATION OF THE CHARACTERISTICS OF A LITHIUM PLASMA SOURCE. Pankratov, V. G.; Zhulebin, L. I.; Stepanov, V. N. High Temp. (USSR) (Engl. Transl.); 9: No. 2, 220-4(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 246-50(Mar-Apr 1971).

The principal characteristics of a lithium plasma source are calculated on the basis of the channel model of an arc in which the conducting region is extended over the whole cross section of the channel. The results of the calculation agree reasonably well with the experimental characteristics obtained when studying a plasma source in which the arc was stabilized by the walls and by radiative cooling. (auth)

11140 FORMATION OF A PLASMA JET IN AIR AT ATMOSPHERIC PRESSURE. Komel'kov, V. S.; Modzolevskii, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 758-64(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 963-71(May 1971).

By using high-pressure discharges one can generate plasma jets of extremely high density without resorting to additional measures to compress or focus them. An electrode design that can be used to form a continuous plasma piston capable of good gas trapping is described; the piston uses high current densities and high magnetic fields in air at atmospheric pressure. The required current densities and accelerating magnetic fields are estimated. It is possible to use several half-periods of the discharge current to trap and accelerate gas in high-frequency, high-current pulsed circuits. The snowplow model is used to calculate the trajectory and velocity of the current fronts during the first half-period, and the constant-mass model is used to calculate these quantities during the second half-period. Except for the initial stages of acceleration the calculated and experimental results are in good agreement. (auth)

11141 NEW IONIZATION MODEL FOR LASER-PRODUCED PLASMAS BY MEANS OF HIGH-ORDER RAMAN-ANTISTOKES LIGHT. Mennicke, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 37A: No. 5, 381-2(20 Dec 1971).

The possibility of producing the first free electrons in a laser-produced plasma by means of high-order Raman–Antistokes light in a normal photoionization process is considered. The experimental observation of higher-order Raman–Antistokes light in solid H_2, D_2, and N_2 is also reported. (auth)

11142 LASER-PLASMA GENERATION FROM A DEUTERIUM ICE PELLET FREELY FALLING WITHIN A SUPERCONDUCTING MAGNETIC BOTTLE. Tanimoto, M.; Kitsunezaki, A.; Sekiguchi, T. (Tokyo Univ.). J. Phys., E (London); 5: No. 1, 27-30(Jan 1972).

An experimental system is described for the production of an isolated plasma blob from a freely falling, isolated deuterium ice pellet by means of a high-power giant-laser pulse. A falling pellet, with dimensions ranging from 0.1 to 0.4 mm (with 5×10^{16} to 3×10^{18} atoms), is detached from the freezer head by gravity and is captured by the focused high-power laser beam pulse after falling freely through about 10 cm. The plasma thus produced in a vacuum chamber is confined in a magnetic cusp or mirror field produced by a pair of superconducting coils. (auth)

11143 IMPROVEMENTS IN AND RELATING TO THERMONUCLEAR PLASMA PRODUCING ARRANGEMENTS. Kapitza, Petr Leonidovich (to Institut Fizicheskikh Problem Akademii Nauk, SSSR). British Patent 1,256,686. 15 Dec 1971. Priority date 22 Aug 1969, Russia.

A resonant cavity filled with deuterium or tritium is described. The cavity is fed with hf electromagnetic waves by means of a coupling element to produce an electric discharge within the working medium. The device contains means for compressing and rotating the gas about the horizontal axis of the cavity. The design and operation are described. (M.O.W.)

Stability

Refer also to abstract 11221.

11144 (CEA-CONF-1848) STABILIZATION OF AN UNSTABLE MODE BY NONLINEAR COUPLING TO DAMPED WAVES. Berthomieux, A.; Laval, G.; Pellat, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 12p. (CONF-711016-3). Dep. NTIS (U. S. Sales Only).

From Conference on plasma theory; Kiev, USSR (19 Oct 1971).

The stabilization of an unstable mode by nonlinear coupling with two damped modes is discussed. It is known that such stabilization is possible using the random-phase approximation to compute the resonant mode–mode coupling interaction; in this case a stable equilibrium state is found for the amplitudes. The coherent interacting wave model is, however, better suited to describe the case of an unstable wave excited with a narrow beam of particles, in which finite dimensions play a significant role. The stabilization of a coherent unstable wave by resonant mode–mode coupling with two damped coherent waves is then considered. A quasi-stationary equilibrium always exists but the stability conditions associated with this type of equilibrium are very restrictive. (France)

11145 (MATT-872) NONLINEAR PROPERTIES OF KINK AND TEARING INSTABILITIES IN TOKAMAKS. Rutherford, P. H.; Furth, H. P. (Princeton Univ., N. J. Plasma Physics Lab.). Dec 1971. Contract AT(30-1)-1238. 16p. (CONF-711016-6). Dep. NTIS.

From Conference on plasma theory; Kiev, USSR (19 Oct 1971).

Experimentally observed tokamak MHD modes have singular surfaces falling into the plasma region and are, therefore, of the finite-resistivity type. Stability boundaries for these modes are presented for typical current profiles: for centrally peaked profiles the higher-m modes become stable. At low resistivity the diamagnetic drift terms become important. It is shown that the tearing instability remains, but the mode now involves a large drift-wave component. In realistic cases, MHD kinks were previously shown to have stable secondary helical equilibria: these are computed for typical cases and compared with the amplitudes of the observed precursor oscillations. (auth)

11146 NONLINEAR ELECTRON-CYCLOTRON DRIFT INSTABILITY AND TURBULENCE. Forslund, D. W.; Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 21, 1424-8(22 Nov 1971).

The cross-field anomalous resistivity due to the electron-cyclotron drift instability is shown to persist in the nonlinear regime as a result of mechanisms that depend critically on the magnitude of the magnetic field. (auth)

11147 TOROIDAL EQUILIBRIUM FOR A HIGH-β THETA-PINCH PLASMA. Berge, Gerhard (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 15: No. 1, 150-9(Jan 1972).

The effect of superimposing a time-oscillating l = 1 helical mode on a static straight theta pinch is investigated. The stability obtained for the m = 1 mode can be used to support the toroidal force, which is introduced ad hoc. Conditions for obtaining toroidal equilibrium by this technique are obtained. The theory is within the framework of ideal magnetohydrodynamics. (auth)

11148 SHARP-BOUNDARY MODEL OF A HIGH-PRESSURE TOKAMAK. Haas, F. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids; 15: No. 1, 141-3(Jan 1972).

A simple sharp-boundary model for a high-pressure tokamak is described. Its relationship to the recent work of Greene, Johnson, and Weimer is demonstrated. (auth)

11149 CONTRASTREAMING INSTABILITY IN A ONE-DIMENSIONAL FINITE-LENGTH SYSTEM. Lin, A. T.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). Phys. Fluids; 15: No. 1, 166-70 (Jan 1972).

Two independent and oppositely directed electron beams with equal densities and speeds are considered to interpenetrate one another in a finite-length system with a stationary neutralizing ion background. The nonlinear development of the resulting electrostatic waves is followed both in time and space by numerical simulation. The results include the time-dependent behavior of the particle trajectories governed by the equation $W = \frac{1}{2}mv^2 - |q\phi_0(t)| \cos k_{max} z$. In the cold beam case a hysteresis-like loop in phase space is observed to develop in the transition from the laminar to a turbulent state. The vortices formed in velocity space are found to be absorbed at the right-hand boundary of the finite-length system and coalesce into one another for all warm beam cases. The total electric field energy saturates at approximately 16% of the total system energy. This result is three times greater than for a one-dimensional system with periodic boundary conditions. (auth)

11150 EFFECTS OF INHOMOGENEITIES IN PLASMA DENSITY ON THE BEAM–PLASMA INSTABILITY AND LANDAU DAMPING. Lin, A. T.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). Phys. Fluids; 15: No. 1, 171-7(Jan 1972).

A numerical computer simulation using a charge sheet model is employed to investigate the beam–plasma instability and Landau damping in a one-dimensional, finite-length, inhomogeneous plasma. The results confirm the theoretical predictions that the inhomogeneities in plasma density distribution reduce the spatial growth rate of the beam–plasma instability and increase the Landau damping rate. (auth)

11151 NONLINEAR EVOLUTION OF THE DORY–GUEST–HARRIS INSTABILITY. Joyce, Glenn; Knorr, Georg (Univ. of Iowa, Iowa City). Phys. Fluids; 15: No. 1, 177-82(Jan 1972).

The nonlinear evolution of the Dory–Guest–Harris type instability is investigated by numerical integration of the Vlasov equation in one spatial and two velocity dimensions. Two methods are used: a particle simulation and the Fourier–Hermite transform. The two methods are compared for $f_0(v_\perp) = (2\pi 5!)^{-1} \times (v_\perp/\sqrt{2})^{10} \exp(-v_\perp^2/2)$ for k values that are unstable. A method of predicting the limiting amplitude of the electric field is presented for the case in which one mode dominates the system. (auth)

11152 INSTABILITY OF SPATIALLY SEPARATED PLASMA BEAMS. Bogdanov, E. P.; Orlov, L. K.; Romanov, Yu. A. (Gorky State Univ., USSR). Izv. Vysah. Ucheb. Zaved., Radiofiz.; 14: No. 6, 805-12(1971). (In Russian).

The instability of spatially separated two-temperature plasma beams is investigated in a quasi-hydrodynamic approximation. The instability boundaries and the increments of amplified waves were found. The study includes the dependences of the minimum relative drift velocity of beams at which the instability occurs and the dependence of the maximum spatial increment of the amplified waves versus the system parameters, the collision frequency, the ratios of the thermal velocities, and the plasma frequencies of charged particles. The results obtained point to the possibility of realizing the considered instability in semiconductor plasmas. (auth)

11153 STABILITY OF AN ANISOTROPIC PLASMA JET. Raghavachar, M. R. (Mysore Univ. Post-Graduate Centre, Mangalore, India). J. Plasma Phys.; 6: 237-48(Oct 1971).

The stability of an anisotropic plasma jet was investigated using equations of Chew, Goldberger, and Low (1965) in both plane and cylindrical geometries. The main conclusions are as follows: (i) For waves of small wavelength, when λ (the ratio of plasma density to the density of surrounding nonconducting medium) is much greater than unity, the plasma jet is stable only if $\frac{1}{6}(1 + \sigma) < p_{||}/p_\perp < 1 + 2\sigma$, where $p_{||}$ and $p_\perp$ denote the components of pressure parallel and perpendicular to the direction of magnetic field in the steady state, and σ denotes the ratio of magnetic pressure to the perpendicular component of plasma pressure. (ii) When $\lambda \ll 1$, the plasma jet is unstable if the parallel component of pressure exceeds the sum of the perpendicular component of pressure and twice the magnetic pressure of the plasma. (iii) For long waves, there exists an infinite number of growing and decaying waves. Expressions for the growth rates were obtained. (auth)

11154 INSTABILITIES IN A MAGNETOPLASMA WITH SKIN CURRENT. Liu, Chuan Sheng (Univ. of California, Los Angeles. Inst. of Advanced Study, Princeton, N. J.). Contract AT(30-1)-3917. Phys. Rev. Lett; 27: No. 24, 1637-40(13 Dec 1971).

Stability of a magnetized plasma with skin current, characterized by nonuniformity of the current and the electron temperature, is analyzed for perturbations with frequency and growth rate higher than the ion gyrofrequency. New instabilities due to the electron temperature gradient are found in both ion and electron acoustic branches, important for experiments with turbulent heating. The ion–acoustic instability observed in experiments leads to a Bohm-

like turbulent thermal conductivity. The theoretical results, both linear and nonlinear, agree well with experiment. (auth)

11155 STABILITY OF A PLASMA IN THE FIELD OF A LONGITUDINAL MONOCHROMATIC WAVE. Bud'ko, N. I.; Karpman, V. I.; Shklyar, D. R. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1463-76(Oct 1971). (In Russian).

Satellite excitation by a Langmuir wave is considered by taking into account the nonstationary distribution function of a plasma in the field of a wave. The behavior of the satellite amplitude near the stability threshold is investigated. The relation to the parametric mechanism of satellite excitation is considered. It is shown that, under the conditions of the experiments, satellite excitation is due to instability of the nonparametric type. (auth)

11156 EFFECT OF FINITE LARMOR RADIUS ON RAYLEIGH–TAYLOR INSTABILITY OF A PLASMA IN THE PRESENCE OF A VERTICAL MAGNETIC FIELD. Ariel, P. D. (Malaviya Regional Engineering Coll., Jaipur, India). Nuovo Cim.: 6B: No. 2, 124-30 (11 Dec 1971).

The character of equilibrium of an inviscid, incompressible, rotating plasma of variable density in the presence of a vertical magnetic field is investigated while taking into account the effects of finite Larmor radius. The solution is demonstrated to be characterized by a variational principle, and it is shown that the system cannot be over-stable. Based on the existence of a variational principle, a solution is developed for the problem of a plasma with finite depth and exponentially varying density. It is found that the basic criterion of stability remains unaffected by the effects of rotation and finite Larmor radius taken together or separately. (auth)

11157 EFFECTS OF NONUNIFORM RADIAL ELECTRIC FIELDS ON PLASMA LOW-FREQUENCY STABILITY. Bardotti, G.; Dobrowolny, M. (EURATOM–CNEN, Frascati, Italy). Nuovo Cim.; 6B: No. 2, 139-52(11 Dec 1971).

The stability of a low-β magnetized plasma column, in the presence of radial nonuniform electric fields, is numerically investigated in a weakly collisional regime. The analysis is for electrostatic low-frequency perturbations of the drift type. Numerical results for the frequency and the growth of the waves are presented as a function of the electric-field amplitude and the dimensionless parameter $\epsilon^* = \omega^* \nu_{ei}/k_\parallel^2 v_e^2$ (ω^* being the drift frequency, ν_{ei} the electron–ion collision frequency, v_e the electron thermal speed and $k_\parallel$ the wave number component parallel to magnetic lines). It is shown that in the presence of a nonuniform electric field more than one mode can be unstable. (auth)

11158 ROLES OF ION MOTION AND OF RETURN CURRENTS IN TRANSVERSE INSTABILITY OF COLLIDING PLASMAS. Nebenzahl, I. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids; 15: No. 2, 311-16(Feb 1972).

Proper account of the ion dynamics is shown to lead to a significant change in the extent of the unstable range of transverse modes. However, no very high growth rates can be produced by the ions. For relativistic electron beams in a cold plasma, the roles of return currents induced in the plasma and of plasma collisions are analyzed. The return currents do not influence the transverse instability except for the extreme relativistic region $\gamma n_b/n_p > 1$, where the plasma electrons "take over" in maintaining the growth rate high. Collisions are unimportant unless their frequency, $\nu \geq \omega_p^2$ (plasma)$/\omega_p$(beam), where transverse oscillations cease to be electrically neutralized, so that pinching becomes impossible and the growth rate of the instability goes to zero as $1/\nu$. (auth)

11159 NONLINEAR DEVELOPMENT OF ELECTROMAGNETIC INSTABILITIES IN ANISOTROPIC PLASMAS. Davidson, Ronald C. (Univ. of Maryland, College Park); Hammer, David A.; Haber, Irving; Wagner, Carl E. Phys. Fluids; 15: No. 2, 317-33(Feb 1972).

Theory and simulation experiment are presented for a wide variety of transverse electromagnetic instabilities in plasmas with different sources and degrees of anisotropy. In each of the electron bi-Maxwellian, electron-pinch, and ion-pinch experiments, the bulk response of the system during the initial stages of instability is in good agreement with the predictions of quasi-linear theory. Furthermore, the two independent energy constants that derive from the fully nonlinear Vlasov–Maxwell equations are found to remain constant to very good accuracy, even when the magnetic field energy reaches a substantial fraction of the total system energy. In each simulation experiment it is found that the magnetic energy saturates, once the magnetic bounce frequency has increased to a value comparable to the linear growth rate prior to saturation, i.e., when $\omega_B \sim \gamma_k$. It is concluded that amplitude limitation for Weibel instabilities is a result of magnetic trapping for a broad range of system parameters. In many experiments a large remnant anisotropy in kinetic energy persists long after saturation. (auth)

11160 OSCILLATIONS OF A WEAKLY IONIZED INHOMOGENEOUS PLASMA. Al'terkop, B. A.; Shvilkin, B. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 775-9(Nov 1971). Translated from Zh. Tekh. Fiz.; 41: No. 5, 985-91(May 1971).

A theoretical and experimental study was made of instabilities in a weakly ionized inhomogeneous plasma. The analysis is based on the kinetic equations with a model collision integral. Taking account of the finite ion temperature improves the agreement between theory and experiment. The theoretical conditions for the excitation of oscillations with various azimuthal numbers are in satisfactory agreement with experiment. (auth)

11161 PLASMA FLUCTUATIONS IN A MAGNETIC MULTIPOLE. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Repalov, N. S. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 723-30(Nov 1971). Translated from Zh. Tekh. Fiz.; 41: No. 5, 917-27(May 1971).

Theoretical and experimental investigations were carried out to study the interchange instability in a multipole magnetic field. If the ion cyclotron radius is comparable with the perturbation wavelength the stability of the plasma is not determined by the requirement that the specific flux volume be a minimum but by the condition that the length of a closed magnetic line of force be a minimum. At the same time there is a reduction in the volume of plasma that is stable against magnetohydrodynamic perturbations; the penetration depth of the plasma fluctuations through the critical magnetic surface ψ_c increases with decreasing multipole order. (auth)

11162 CORRELATION STUDIES OF THE INTERCHANGE INSTABILITY IN A MULTIPOLE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Tereshchenko, F. F. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 731-6(Nov 1971). Translated from Zh. Tekh. Fiz.; 41: No. 5, 928-36(May 1971).

Correlation methods are used to study the relation between the fluctuations and diffusion in a linear octupole magnetic system. Power spectra for the fluctuations and the dispersion relation for the instability are presented. Measurements are presented for the coefficients of turbulent diffusion, and it is found that the coefficient of turbulent diffusion is comparable with the classical value near the bounding magnetic surface defined by the minimum length for a closed magnetic line of force. The coefficient is close to the Bohm value reasonably far from the critical magnetic surface. (auth)

11163 STABILITY OF A FIELD-FREE CONSTRICTED PLASMA BETWEEN ELECTRODES. James, M. K.; Seymour, P. W. (Univ. of Adelaide). Aust. J. Phys.; 24: No. 5, 687-704(Oct 1971).

Basic equations for a general plasma system in contact with internal and vacuum magnetic fields are discussed. For the stability analysis of a plasma between electrodes, the validity of the energy approach used is established by a brief discussion. The energy principle is then employed to derive a stability criterion for a sheet-current version of a field-free constricted discharge having a boundary surface that approximates a hyperboloid of one sheet, and the critical current for the onset of instability is expressed in terms of the initial conditions of an idealized experiment. A useful geometrical interpretation of the criterion is included. For identical external conditions and plasma geometry, the critical current is found to be greater than that obtained approximately by Seymour and exactly by James for a system with interdiffused magnetic field and plasma. (auth)

Thermonuclear Processes

Refer also to abstracts 10021 and 10121.

11164 (UCRL–73517) MAGNETIC MIRROR SYSTEMS. Post, R. F. (California Univ., Livermore. Lawrence Livermore Lab.). 10 Nov 1971. 49p. (CONF-711127–1). Dep. NTIS. From Hearings on controlled thermonuclear research conference; Washington, D. C. (10 Nov 1971).

A review is given of the fundamental problems concerning magnetic mirror machines. Prospects for an experimental mirror machine reactor are discussed. The progress to date, problems to be solved, and program steps are outlined. (M.O.W.)

11165 GENERATION OF ASTRON-TYPE E LAYERS USING VERY HIGH-CURRENT ELECTRON BEAMS. Andrews, M. L.; Davitian, H.; Fleischmann, H. H.; (and others) (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 27: No. 21, 1428-31(22 Nov 1971).

Reversal of the axial magnetic field in a magnetic-mirror trap is achieved by injection of a 30-kA, 0.34-MeV beam of electrons. (auth)

11166 SOURCE FOR HIGHLY STRIPPED IONS. Stix, Thomas H. (to United States Atomic Energy Commission). U. S. Patent 3,611,029. 5 Oct 1971. Filed 9 Sep 1969.

An apparatus is described for producing highly stripped ions by sufficient exposure of these ions to a cloud of energetic electrons. The apparatus claims to do the following; produces an electrostatic negative potential well capable of confining these ions during the stripping process; creates magnetic and electrostatic forces capable of confining the energetic electrons forming the electron cloud with only a low rate of electron loss and a slow dissipation of electron energy; and contemplates means for producing a transverse electric field that removes electrons undesirably trapped in electrostatic positive potential maxima. (auth)

11167 VELOCITY DISTRIBUTION OF THE IONS PRODUCING NEUTRONS IN A PLASMA FOCUS. Conrads, H.; Cloth, P.; Demmeler, M.; Hecker, R. (EURATOM-Kernforschungsanlage, Julich, Ger.). Phys. Fluids; 15: No. 1, 209-11(Jan 1972).

There is evidence for a noncollision-dominated velocity distribution (average energy of at least 20 keV) of the ions producing the neutrons in a dense plasma focus. For a group of ions moving in the axial direction the average energy is at least 0.3 MeV. (auth)

11168 TIME-RESOLVED ROSS FILTER SYSTEM FOR MEASURING X-RAY SPECTRA IN Z-PINCH PLASMA FOCUS DEVICES. van Paassen, Hugo L. L. (Aerospace Corp., El Segundo, Calif.). Rev. Sci. Instrum.; 42: No. 12, 1823-4(Dec 1971).

The development of plasma pinch and other flash x-ray devices has created the need for a system capable of measuring the spectra of 50-nsec x-ray pulses. A Ross filter system used in conjunction with silicon diode x-ray detectors gives nanosecond time resolution in spectral intervals between 5.46 and 115.6 keV. (auth)

11169 COMPUTATION OF E-LAYER AND PLASMA EQUILIBRIA IN ASTRON. Anderson, David V.; Killeen, John; Rensink, Marvin E. (Univ. of California, Livermore). Phys. Fluids; 15: No. 2, 351-8(Feb 1972).

The equilibrium magnetic field for astron configurations is computed; a given vacuum magnetic field and the fields due to the E layer and plasma are included, assuming axial symmetry and $B_\theta \equiv 0$. The components $B_r(r,z)$ and $B_z(r,z)$ are derived from the stream function $\psi(r,z) = rA_\theta$. The E-layer is described by a distribution function that depends on the canonical angular momentum and the energy. Various models of the E layer were used and are discussed. The function $\psi(r,z)$ satisfies a nonlinear partial differential equation (Ampere's law) that is solved by finite-difference methods, using an iterative procedure. The object is to find equilibrium solutions with a reversed field in the central region that can contain a plasma. Examples of reversed-field equilibria corresponding to various E layer distributions are presented. Simple models for the plasma are assumed, and equilibria of the coupled system of E layer plus plasma are computed. (auth)

11170 DEPENDENCE OF FLUCTUATION LEVEL ON THE MAGNETIC FIELD CONFIGURATION IN THE SPHERATOR. Okabayashi, M.; Freeman, R. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 2, 359-63(Feb 1972).

The fluctuation level and the plasma confinement time were investigated by changing the shear length and average magnetic well in the spherator, a toroidal plasma confinement system. The experimental results show that the plasma is unstable when the mirror-trapped particles are located in the bad-curvature section, even if the average curvature is favorable. (auth)

11171 NONUNIFORMITIES IN MAGNETIC FIELD OF A LINEAR θ PINCH. Popova, V. A.; Shneerson, G. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 684-9(Nov. 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 865-72(May 1971).

A procedure is described for calculating the radius of curvature ρ of the magnetic lines of force of a θ pinch. It is shown that, in a solenoid with transverse cuts, ρ can be expressed in terms of the normal and tangential derivatives of the potential at the boundaries of the conductors. (auth)

11172 ROCKET PROPULSION BY THERMONUCLEAR MICRO-BOMBS IGNITED WITH INTENSE RELATIVISTIC ELECTRON BEAMS. Winterberg, F. (Univ. of Nevada, Las Vegas). Raumfahrtforschung; 15: No. 5, 208-17(Sep-Oct 1971).

A method for the ignition of a thermonuclear micro-bomb by means of an intense relativistic electron beam is discussed with regard to its potential application to rocket propulsion. With such a system, exhaust velocities up to 10^3 km/sec, corresponding to a specific impulse of 10^5 sec, seem to be within the realm of possibility. The rocket is propelled by a chain of thermonuclear micro-bombs exploded in a concave magnetic mirror produced by superconducting field coils. The magnetic pressure of the field reflects the fireball generated by the explosion. For the large capacitor bank required to generate the intense relativistic electron beam, a desirable light-weight design may be possible through use of ferroelectric materials. Because of the high cost of the T–D and ^{3}He–D thermonuclear material, the system has to be optimized by minimizing the T–D, ^{3}He–D consumption by a proper T–D, ^{3}He–D fuel to hydrogen propellant mass ratio, leading to a larger total system mass than would be absolutely necessary. (auth)

11173 RADIOLOGICAL IMPACT OF FUSION. Steiner, Don (Oak Ridge National Lab., Tenn.). New Sci.; 52: No. 774, 168-71(16 Dec 1971).

Although they are often heralded as the "clean source of power," fusion reactors will entail the handling and control of significant quantities of radioactive materials. However, the harmful effects of radiation from fusion power are expected to be less severe than those from fission power. The inventories of radioactive materials anticipated in fusion reactors are compared, both qualitatively and quantitatively with those characteristics of fission reactors. Through such a comparison the radiological impact that may accompany power by fusion is considered, and quantitative arguments are given in an area that previously received only qualitative arguments. (UK)

Wave Phenomena

Refer also to abstracts 11127 and 11129.

11174 (CEA-CONF-1862) HIGH FREQUENCY FLUCTUATIONS IN THE DENSITY GRADIENT OF AN ALKALI PLASMA. Brossier P.; Deschamps, P.; Gravier, R.; Renaud, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 6p. (CONF-710929–2). Dep. NTIS (U. S. Sales Only).

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Drift wave modes in a potassium plasma in the double ended EPAL Q-machine were studied. The potassium plasma has the following characteristics, a density varying between 10^8 and 10^{10} cm^{-3}, a length of 200 cm, a magnetic field up to 10,000 G and a temperature of 2,200 deg K (end plates). Measurements were made on azimuthal modes with m = 1 up to 10, which are seen to be localized in the density gradient where the electric field is weak. The spectrum can be monochromatic and the higher modes can be above the ion cyclotron frequency. Evolution of this spectrum into a turbulent spectrum (amplitude $\alpha\omega^{-2}$) is obtained by increasing the magnetic field. (France)

11175 (FRNC-TH-118) PROPAGATION OF FREQUENCY-MODULATED ELECTROMAGNETIC WAVES THROUGH COLD PLASMAS: ASSOCIATED NONLINEAR EFFECTS. Allanche, Jean-Daniel (Paris Univ. (France). Faculte des Sciences). 1970. 117p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The nonlinear response of a plasma to a frequency modulated electric current (nonpropagative case), and the nonlinear phenomena associated with the propagation of a modulated electric wave are analyzed (propagative case). The electric field consists of two superimposed fields, only one of them being frequency-modulated. In order to establish the expression for the electron current density in the nonpropagative case, stationary solutions are assumed; they are expanded in multiple Fourier series. The induced electric current demonstrates the effects of disymmetry in the modulated signal (self-modulation) and of crossed modulation (generation of harmonics). In the propagative case, the Boltzmann equations enable the isotropic and anisotropic components to be determined, these functions depending upon the position vector. The collision frequency intervenes in the various expressions for the conductivities, (both isotropic and anisotropic). The results obtained confirm the importance of the electron–molecule interaction law in explaining the macroscopic phenomena. Physical and experimental applications are envisaged (new method of diagnostics). (France)

11176 TRAVELING-WAVE ANTENNA FOR EXCITING WAVES IN A CYLINDRICAL ANISOTROPIC PLASMA. Hipp, Jackie E.; Kristiansen, Magne; Hagler, Marion O. (Texas Technological Univ., Lubbock). J. Appl. Phys.; 42: No. 12, 4887-98(Nov 1971).

Several variations of a newly proposed device for exciting ion

cyclotron waves in a magnetoplasma are analyzed theoretically and numerically. The results of this analysis are compared with those of a similar analysis of a Stix coil. The new coupler is composed of a set of identical helical straps driven by a multiphase rf source and excites waves that vary azimuthally as $e^{jm\theta}$, where $m = \pm 1, \pm 2, \ldots$. The analysis reveals that the new coupler offers the following advantages over the Stix coil: (i) a certain degree of control over radial variations of accelerating fields, (ii) a preferred direction of propagation, (iii) more energy coupled into propagating waves (for a given input current), (iv) maximum loading resistance at a higher plasma density, and (v) a slightly wider effective density range for propagating waves. (auth)

11177 PARAMETRIC EXCITATION OF TRANSVERSE AND LONGITUDINAL WAVES NEAR THE PLASMA FREQUENCY. Bodner, Stephen E.; Eddleman, James L. (Univ. of California, Livermore). Phys. Rev., A; 5: No. 1, 355-6(Jan 1972).

Intense laser light with frequency ω_0 near the plasma frequency excites transverse waves with real frequency components 0 and $\pm 2\omega_0$ and longitudinal plasma oscillations at $\pm\omega_0$. The resonant coupling is due to the $\vec{v} \times \vec{B}$ forces and relativistic mass corrections. The maximum growth rate is $\omega_0 v_0^2/16c^2$, where v_0 is the maximum electron velocity in the incident laser light. (auth)

11178 THEORY OF LAMINAR COLLISIONLESS SHOCKS. Forslund, D. W.; Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 18, 1189-92(1 Nov 1971).

A theory is derived that qualitatively and quantitatively explains the similarity between numerical simulations for electrostatic and perpendicular magnetic collisionless shocks for zero ion temperature and no anomalous resistance. (auth)

11179 MAGNETOHYDRODYNAMIC WAVES IN A TWO-COMPONENT PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 9-13(1969). (In Russian).

The effect of particle collisions on a low-frequency oscillation in a magnetoactive two-component plasma was investigated with a nonlinear model of a Boltzmann kinetic equation. The result was a dispersion equation that agrees with an earlier-obtained equation from crossed electron collisions with ions in a plasma, and also electron–electron collisions. Thus, particle collisions do not influence the character of the propagation of Alfven waves in a plasma. (K.S.W.)

11180 DENSE PLASMA AS A BINARY GAS. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 14-19 (1969). (In Russian).

It had been previously shown by the author that a sufficiently dense, fully ionized plasma, with respect to longitudinal vibrations, behaves like an ordinary binary gas, i.e., a mixture of two chemically unreactive gases. The starting point had been a kinetic model of Boltzmann's equation for gaseous mixtures. In this paper the same theorem is demonstrated, but employing the method of hydrodynamic approximation, and starting with a high-temperature, fully ionized plasma. The theoretical development leads to an equation that proves the propagation of ordinary sound waves in such a plasma, provided the latter is sufficiently dense and isothermal. (K.S.W.)

11181 ELECTROMAGNETIC WAVES IN A DENSE PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 25-7(1969). (In Russian).

In an attempt to characterize the propagation of linear electromagnetic vibrations in a plasma, the original equations are first linearized. Using the hydrodynamic approximation, the equations are written to describe two components of the plasma. Results are theoretically developed for both rarefied and dense plasmas. It is noted that a sufficiently dense plasma behaves with respect to the propagation of electromagnetic waves like an ordinary neutral gas. (K.S.W.)

11182 ELECTROMAGNETIC WAVES IN A DENSE PARTIALLY IONIZED PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 28-32(1969). (In Russian).

The distribution of electromagnetic waves in a partially ionized plasma without an external magnetic field is treated within the framework of the hydrodynamic approximation. It was desired to solve the problem for a rarefied plasma as well as the dense version. The original linearized equations of motion are developed jointly with Maxwell's system of equations. It is shown that a sufficiently dense gas is similar to an ordinary neutral gas in which the dispersion law applies to electromagnetic waves. (K.S.W.)

11183 TRANSVERSE ELECTROMAGNETIC OSCILLATIONS AND WAVES IN A PARTIALLY IONIZED PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 33-7(1969). (In Russian).

In an incompletely ionized gas there are both neutral and charged particles, and in a theoretical treatment it is essential to consider all components. This is especially true in a sufficiently dense gas where the collision frequency of particles is an order of magnitude higher than the frequencies of the varying plasma processes. Starting with a nonlinear model of Boltzmann's equations, the development is conducted jointly with Maxwell's electrodynamic equations so as to describe transverse electromagnetic vibrations in a ternary isothermal plasma. The dual results are descriptive of the prevailing conditions in a rarefied plasma and a highly dense plasma. (K.S.W.)

11184 NONLINEAR INTERACTION OF MAGNETO-IONIC WAVES. Daneliya, I. A. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 75-8(1969). (In Russian).

Maintenance of a plasma in a fixed volume is accomplished by an external field, around which revolve electrons and positive ions in Larmor orbits. The theoretical development begins with hydrodynamic equations which describe the motion of these electrons and ions, and yields an equation that illustrates a reciprocal proportionality of the first power of the magnetic field, the so-called "anomalous" plasma diffusion. (K.S.W.)

11185 ION OSCILLATION IN A DENSE PARTIALLY IONIZED PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 49-53(1969). (In Russian).

Longitudinal ion vibrations in partially ionized, nonisothermal plasma were studied, using the hydrodynamic approximation. The results were in complete uniformity with the author's previous work, using a multicomponent system of the Boltzmann model equation. The reliability and correctness of the model kinetic equation is noted. (K.S.W.)

11186 LONGITUDINAL OSCILLATIONS AND WAVES IN A PARTIALLY IONIZED PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 38-43(1969). (In Russian).

In the transitional state of plasma, when the temperature of the electrons and ions are nearly the same, but insufficiently high for complete ionization of neutral molecules, the plasma contains both charged and neutral particles. At sufficiently high densities a number of properties may be observed that are characteristic of a ternary gas mixture. The model Boltzmann approximation was used so that a rarefied plasma would manifest its own properties, and a dense plasma behaves like a three-component mixture. The theoretical development demonstrates that gas and group-wave speeds agree and that the coefficient of sound absorption depends upon the viscosity of the mixture, not on the coefficient of thermal conductivity. (K.S.W.)

11187 LONGITUDINAL OSCILLATIONS AND WAVES IN A DENSE THREE-COMPONENT PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 44-8(1969). (In Russian).

For the correct description of a sufficiently dense plasma it is feasible to use the so-called hydrodynamic approximation. In equations for averaged velocities, the pressure obtained acts only on the separate components of the plasma and allows an approximate description of the effect of thermal motion. Longitudinal vibration was studied in a partially ionized plasma containing both charged and neutral particles. The results are in complete agreement with the dispersion equations for longitudinal waves in a dense, three-component plasma (without a magnetic field) previously obtained by the author. (K.S.W.)

11188 RESONANT WAVE–PARTICLE INTERACTION IN NONUNIFORM PLASMAS. Saitta, L.; Engelmann, F. (Laboratori Gas Ionizzati, Frascati, Italy). Z. Naturforsch.; 26a: No. 9, 1528-30(Sep 1971).

The appearance of resonant-particle effects in the linear dynamics of electron waves in a plasma whose electrons are trapped in a potential trough is discussed and conditions for the characteristic times involved are derived. For the special case of a parabolic potential trough it is shown that, within a limited time interval, a strong resonant effect may occur due to the interaction of a wave with all particles, which is not contained in the solutions given so far. (auth)

11189 RELATIVISTIC DOPPLER EFFECT AND GROUP VELOCITY IN HOMOGENEOUS NONLINEAR AND INHOMOGENEOUS PLASMAS. Nicolis, John S.; Athanassoula, E. (Democritus Nuclear Research Center, Athens). Z. Naturforsch.; 26a: No. 9, 1531-8(Sep 1971).

Variations of the frequencies (Complex Doppler effect) from a source moving uniformly in a homogeneous isotropic plasma and emitting a uniform EM plane wave with amplitude E_0, as a function of ω_e/E_0 where ω_e is the plasma frequency, were studied. The

ratio of the velocity U of the source over the group velocity U_{gr} of the transmitted wave is then calculated from the slope of the Doppler curves. When the plasma is inhomogeneous (one-dimensional stratification) the Doppler effect depends on the particular profile of the refractive index and its higher (even) derivatives with respect to the direction of stratification z. In this case the ratio $U/U_{gr} = f(z)$ is given as the solution of a higher order differential equation with the inhomogeneous part depending on the slope of the Doppler curve with respect to frequency. Typical cases involving symmetrical and transition profiles are examined. Harmonic generation in the plasma is not taken into account. (auth)

11190 PROPAGATION AND REFLECTION OF ELECTROMAGNETIC WAVES IN HOT INHOMOGENEOUS PLASMA. Petrzilka, V. A.; Preinhaelter, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 21: No. 10, 1064-70(1971).

Using the WKB method, a local dispersion equation of a right-hand circularly polarized wave and an expression for its electric field are derived, the wave having frequency smaller than the electron cyclotron frequency and propagating in a hot inhomogeneous plasma. The density gradient of the plasma is constant and parallel to an external magnetostatic field. Further, the reflection coefficient of this wave is derived. (auth)

11191 OPTICAL REFRACTIVITY OF PLASMAS. Jahoda, F. C.; Sawyer, G. A. (Los Alamos Scientific Lab., N. Mex.). Methods Exp. Phys.; 9: 1-48(1971).

The refractive index is related to the dispersion relation, and the dispersion relation for free electrons is derived for the case of small-amplitude waves in nearly collisionless cold plasma with or without a stationary magnetic field applied parallel to the direction of wave propagation. Various standard measurements of refractive effects are discussed. Measurements of refraction phenomena by techniques that depend specifically on the long coherence lengths of laser light are discussed. 72 references. (M.O.W.)

11192 EFFECTS OF TEMPERATURE INHOMOGENEITY ON RESONANT BEHAVIOR OF PLASMA COLUMN IN THE PRESENCE OF AN AXIAL MAGNETIC FIELD. St. Germain, R. L.; McIntosh, R. E. (Univ. of Massachusetts, Amherst). J. Appl. Phys.; 43: No. 1, 52-7(Jan 1972).

The effects of thermal inhomogeneities and a weak axial magnetic field on the resonant behavior of a plasma column at microwave frequencies are treated by extending the analysis of Parker, Nickel, and Gould. Temperature inhomogeneities are assumed for the model that yield shifts in the resonant spectra that agree with experiment. These shifts are ascribed to alterations in the electron number density and temperature profiles resulting from the magnetic field. (auth)

11193 EXPERIMENTAL STUDY OF STRONG TRANSVERSE IONIZING SHOCK WAVES. Moriette, Pierre R. (Columbia Univ., New York). Phys. Fluids; 15: No. 1, 51-5(Jan 1972).

Experiments are described in which transverse ionizing shock speeds up to 4×10^8 cm/sec were measured in gaseous hydrogen. Measurements of the magnetic shock structure, shock thickness, and magnetic field jump are described and compared with theoretical predictions. The ion temperature near the device wall was measured by a charge exchange particle detector. A separation distance of about 30 cm between the shock wave and the magnetic piston was measured. (auth)

11194 IONIZING POTENTIAL WAVES AND HIGH-VOLTAGE BREAKDOWN STREAMERS. Albright, N. W.; Tidman, D. A. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 1, 86-90(Jan 1972).

The structure of ionizing potential waves driven by a strong electric field in a dense gas is discussed. Negative breakdown waves are found to propagate with a velocity proportional to the electric field normal to the wavefront. This causes a curved ionizing potential wavefront to focus down into a filamentary structure, and may provide the reason why breakdown in dense gases propagates in the form of a narrow leader streamer instead of a broad wavefront. (auth)

11195 MODE CONVERSION IN AN INHOMOGENEOUS PLASMA. Moore, B. N.; Oakes, M. E. (Univ. of Texas, Austin). Phys. Fluids; 15: No. 1, 144-9(Jan 1972).

An expression for the mode conversion efficiency is derived for waves propagating in an inhomogeneous plasma. Special consideration is given to the effects of finite wave vector parallel to a static magnetic field. It is shown that damping results in a reduction of the efficiency in the immediate neighborhood of the conversion layer. This reduction is partially offset by an increase in efficiency with increased density gradient. Efficiences for plasmas found in tokamaks are presented. (auth)

11196 SPATIAL ELECTRON CYCLOTRON DAMPING. Olson, Craig L. (Univ. of California, Los Angeles). Phys. Fluids; 15: No. 1, 160-5(Jan 1972).

Spatial electron cyclotron damping in an infinite uniform Vlasov plasma is examined. It is found that the plasma response to a steady-state transverse excitation consists of several terms (dielectric-pole, free-streaming, and branch-cut), but that the cyclotron-damped pole term is the dominant term for $z > 1 \approx c/\omega_{ce}$ provided $(\omega_{pe}/\omega_{ce})^2(c/a) \gg 1$ (where c is the velocity of light, a is the electron thermal velocity, ω_{pe} is the electron plasma frequency, and ω_{ce} is the electron cyclotron frequency). If the latter inequality does not hold, then the free-streaming and branch-cut terms persist well past $z = c/\omega_{ce}$ as ω_i approaches ω_{ce}, making experimental measurement of cyclotron damping essentially impossible. Considering only $(\omega_{pe}/\omega_{ce})^2 \times (c/a) \gg 1$, the effects of collisions and of a finite-width excitation are investigated. Criteria are established concerning collisional damping, measurable damping-length sizes, and allowed uncertainty in the magnetic field B_0. Results of numerical calculations, showing the regions in the appropriate parameter spaces that meet these criteria, are presented. From these results, one can determine the feasibility of, or propose parameter values for, an experiment designed to measure spatial electron cyclotron damping. It is concluded that the electron temperature T_e should be at least 1 eV, and preferably 10 eV or higher, for a successful experiment. (auth)

11197 NEGATIVE ABSORPTION NEAR THE ELECTRON CYCLOTRON HARMONICS IN WEAKLY IONIZED GASES. Idehara, Toshitaka (Fukui Univ., Japan). J. Appl. Phys.; 43: No. 1, 64-8 (Jan 1972).

Negative absorption of radio-frequency waves is observed near the electron cyclotron harmonics ($f = nf_c$) in weakly ionized plasma. The voltage gains near $f = f_c$ and $f = 2f_c$ are about 7 and 4 dB, respectively. The emissions near $f = nf_c$ ascribed to this phenomenon are observed up to n = 4 in Xe plasma, up to n = 2 in Kr plasma, and only at n = 1 in Ar plasma. Their powers are stronger by several tens of dB than those corresponding to thermal noise. The frequency shift from $f = nf_c$ as a function of the electron–neutral collision frequency is measured and compared with the theoretical result where the electron distribution function is assumed to be a δ function. (auth)

11198 ELECTROMAGNETIC OSCILLATIONS AND WAVES IN A TWO-COMPONENT PLASMA. Bogdanov, A. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 20-4(1969). (In Russian).

Transverse oscillations in a high-temperature plasma in the absence of an exterior magnetic field were investigated, with due regard to the motions of both electrons and ions. The contribution of ions in a dense plasma may be such that electromagnetic waves of certain frequencies penetrate the dense plasma, whereas in a rarefied plasma, waves of a different length affect penetration, corresponding to the frequencies $\omega > \omega_e$, where ω_e is the plasma electron frequency. The phase velocity of propagation of such waves is always greater than the velocity of light in a vacuum, but the group velocity will be smaller. In a dense, high-temperature plasma, electromagnetic waves are propagated practically without difficulty, i.e., similar to an ordinary inert gas. (K.S.W.)

11199 PARAMETRIC INSTABILITY OF A PLASMA DRIVEN BY A HIGH-FREQUENCY, FINITE-WAVELENGTH WAVE. Ott, E. (Naval Research Lab., Washington, D. C.). Phys. Lett.; 37A: No. 4, 281-2(6 Dec 1971).

The parametric instability of an unmagnetized electron–ion plasma driven by a large-amplitude wave whose frequency ω_0 is close to ω_p is investigated. (auth)

11200 RELATIVISTIC EFFECTS IN THE CYCLOTRON ABSORPTION REGION. Ferrari, L. A. (Queens Coll., New York). Phys. Lett.; 37A: No. 4, 307-8(6 Dec 1971).

The broadening of the cyclotron absorption region and a limit to heating by the cyclotron resonance mechanism due to the relativistic increase in particle mass are computed. (auth)

11201 SURFACE OSCILLATIONS OF MAGNETOACTIVE COLLISION PLASMA. Lovetskii, E. E.; Silakov, V. P. (Moscow Engineering-Physics Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 813-16(1971). (In Russian).

The oscillations whose wavelengths are greater than the characteristic size of the plasma inhomogeneity are investigated. Allowance for the plasma particle collisions enables one to clarify the collision effect on the excitation of periodic surface oscillations and to find new oscillation spectra due to collisions. (auth)

11202 INFLUENCE OF COLLISIONS AND RELATIVISTIC EFFECTS ON HIGH-FREQUENCY WAVE PROPAGATION IN MAGNETOACTIVE PLASMA. Krupina, A. E.; Orlova, E. V. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv.

Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 6, 817-22(1971). (In Russian).

Propagation of electromagnetic waves in plasma near the electron cyclotron resonances and perpendicular to an external magnetic field is considered by the kinetic-equation method. Both relativistic effects (Doppler effect of the second order) and collisions are taken into account. The dispersion equations obtained for ordinary and plasma waves near the cyclotron frequency harmonics are analyzed at different parameter values. (auth)

11203 NONLINEAR THEORY OF HYDROMAGNETIC WAVES IN A HIGH-β PLASMA. Dobrowolny, Marino; Rogister, Andre (European Space Research Inst., Frascati, Italy). J. Plasma Phys.; 6: 401-12(Oct 1971).

A nonlinear integro-differential equation is derived, governing the space–time evolution of nonlinear hydromagnetic waves in a finite-β collisionless plasma. The theory is done for quasi-perpendicular propagation, for wave frequencies above ion cyclotron frequency, and for wavelengths smaller than the ion Larmor radius. In the low-β limit, the derived equation reduces to a Korteweg–de Vries equation. (auth)

11204 ELECTROSTATIC WAVES IN PERIODIC INHOMOGENEOUS PLASMA. Bertrand, P.; Feix, M. R.; Baumann, G. (Univ., Nancy). J. Plasma Phys.; 6: 351-66(Oct 1971).

In periodic, inhomogeneous plasma, the dispersion relation $\omega(k)$ can be generalized to a relation $\omega(k,K)$, where K is the wavenumber of the periodic steady state. Two models are studied: the "water-bag" model and the "two-stream" model. The solution for these models is obtained easily by the introduction of a Lagrangian formulation, and results are presented. It is shown that, in the water-bag case, the appearance of narrow bands of allowed frequencies practically discretizes the lower part of the spectrum. In the two-stream case, while the long wavelengths have a smaller growth rate, an increased instability is found for $k/K = \frac{1}{2}$. (auth)

11205 THERMAL AND COLLISIONAL CORRECTIONS TO THE ORDINARY WAVE. Arumi, F. N.; Oakes, M. E. (Univ. of Texas, Austin). J. Plasma Phys.; 6: 343-9(Oct 1971).

A moment approach is used to find the thermal and collisional corrections to the ordinary wave in a plasma. Results are given that include like- and unlike-particle collisions. (auth)

11206 NONLINEAR INTERACTION OF ELECTROSTATIC MONOCHROMATIC WAVES IN A MAGNETOPLASMA. Tataronis, J. A. (Max-Planck-Institut fuer Plasmaphysik, Munich); Teichmann, J. J. Plasma Phys.; 6: 325-9(Oct 1971).

The resonant interaction of three monochromatic waves propagating in a uniform magnetoplasma is considered in the electrostatic approximation. It is shown that, for arbitrary directions of propagation, the coupling coefficients are in general complex and are symmetric with respect to interchanges of the wave vectors. (auth)

11207 PROPAGATION OF ALFVEN WAVES IN ION-SOUND TURBULENT PLASMA. Rogister, Andre (European Space Research Inst., Frascati, Italy). J. Plasma Phys.; 6: 309-23 (Oct 1971).

The propagation of low-frequency, large-scale (compared to the ion Larmor frequency Ω_i and radius R_i), oblique Alfvén waves in a turbulent plasma is investigated in the framework of kinetic theory. The turbulent field is the statistical average of one-dimensional ion-sound waves of very high frequency and short wavelength ($\omega \gg \Omega_i$, $R_e \gg \lambda$). In the absence of resonant-particle effects, and to first order in a finite-Larmor-radius expansion, it is shown that the turbulence can lead either to spatial diffusion (damping) or anti-diffusion (growth), with Bohm scaling, of the low-frequency wave. Finite-Larmor-radius and frequency effects in the propagation of oblique Alfvén waves are simultaneously obtained for arbitrary β plasma; the results can easily be generalized, merely by deforming certain integration contours, to obtain the corresponding Landau decrement. (auth)

11208 WAVE–PARTICLE INTERACTIONS IN ELECTROSTATIC WAVES IN AN INHOMOGENEOUS MEDIUM. Nunn, D. (Imperial Coll. of Science and Tech., London). J. Plasma Phys.; 6: 291-307(Oct 1971).

The system studied is that of a narrow-band electrostatic-wave packet in a collision-free plasma. Inhomogeneous effects are represented by a wave number, which varies linearly with distance. The system is excited by a weak resonant beam, and, to first order in a smallness parameter associated with the weakness of the beam, the resonant-particle distribution function and charge densities are calculated. It is found that second-order resonant particles become stably trapped in the wave, and, after a few trapping periods, make a dominant contribution to the resonant particle charge density. The growth rate due to the resonant beam was found to increase linearly with trapping time, and typically a pulse that traps particles for n trapping periods exhibits a growth rate ~n times the linear Landau value. Furthermore, a reactive component of charge density was found that was able to cause a steady change in wave frequency and wave number. These features of large growth rates and changing frequency should appear in parallel problems involving other wave types. An obvious application is that of vlf emissions in the whistler mode. (auth)

11209 MAGNETOGASDYNAMIC SHOCK POLAR FOR ALIGNED FIELDS. Lynn, Y. M. (Univ. of Maryland, Baltimore). J. Plasma Phys.; 6: 283-90(Oct 1971).

An equation for the magnetogasdynamic shock polar, given in terms of magnetic-induction-polar variables (i.e. the magnetic induction polar), is obtained. Evolutionary and entropy nondecrease conditions, given in terms of these polar variables, assume a very simple form, and admit immediate geometrical interpretation. It is found that this magnetic-induction polar is far more natural and convenient to use than the shock polar given in terms of conventional velocity-polar variables. (auth)

11210 ADIABATIC TRANSVERSE WAVES IN A CONDUCTING GAS. Roberts, B.; Sozou, C. (Univ. of Sheffield, Eng.). J. Plasma Phys.; 6: 249-55(Oct 1971).

The effect of a magnetic field on transverse waves in a perfectly conducting gas rotating like a Rankine vortex about the axis of a cylinder is investigated. The magnetic field is assumed to be in the axial direction. There are three waves: two waves are rotating in the same direction as the gas, one faster and the other slower than the core speed of the gas, and one wave rotates in the opposite direction. (auth)

11211 TRANSFER OF MONOCHROMATIC RADIATION IN A PLASMA. Zakharov, S. D.; Tyurin, E. L.; Shcheglov, V. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1447-51(Oct 1971). (In Russian).

An exact analytic solution is obtained for the problem of propagation of monochromatic radiation pulses of arbitrary shape in an absorbing plasma. The analysis is carried out for the case when radiation reflection can be neglected. An expression is given for the velocity of propagation of a thermal wave in the case of bremsstrahlung absorption of radiation in a plasma with a zero initial temperature. (auth)

11212 THEORY OF NONLINEAR DIFFERENCE EQUATIONS AND RESONANT INSTABILITY OF PHASE OSCILLATIONS IN A MICROTRON AND OF BEAM OSCILLATIONS IN OPEN CAVITIES. Melekhin, V. N. (Physical Lab., Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1319-33(Oct 1971). (In Russian).

A method for solving the nonlinear difference equations describing an oscillatory system is presented. The nonlinear correction to the oscillation frequency is calculated and resonant instability due to nonlinearity at $\nu = \pi/2$ and $\nu = 2\pi/3$ (ν is the oscillation frequency) is investigated. The phase oscillations in a microtron and beam oscillations in open cavities are calculated by means of the nonlinear theory. Conditions are found for which the oscillations are unstable and the physical consequences of the instability are discussed. The conclusions of the theory are compared with the experimental results. (auth)

11213 HIGH-DENSITY RESONANTLY SUSTAINED PLASMA IN A VARIABLE-LENGTH CYLINDRICAL CAVITY. Fredericks, R. M.; Asmussen, J. Jr. (Michigan State Univ., East Lansing). Appl. Phys. Lett.; 19: No. 12, 508-10(15 Dec 1971).

It is demonstrated that linear bounded plasma theory can be used to understand and predict the high-power behavior of a resonantly sustained plasma inside a variable-length cylindrical cavity. Plasma densities of over 11 critical densities ($>10^{12}$ cm^{-3}) can easily be produced by varying the cavity length. (auth)

11214 NONLINEAR INTERACTION OF ELECTROSTATIC WAVES IN A PLASMA. Stenflo, L. (Inst. of Physics, Umea, Sweden). Ann. Phys. (Leipzig); 27: No. 3, 289-95(1971).

Longitudinal waves in a spatially uniform magnetized plasma are studied. It is demonstrated that the coupling coefficients, which describe the interaction between the different waves, can be derived in a comparatively simple way by means of coupled-mode theory even if dissipative effects are taken into account. (auth)

11215 PARALLEL CURRENT AND SHEATH EFFECTS ON COLLISIONAL DRIFT WAVES IN AN AXIALLY SYMMETRIC DEVICE WITH END PLATES. Tsai, Shih-tung; Ellis, Richard F.; Perkins, Francis W. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 2, 345-50(Feb 1972).

A theoretical calculation is made of the normal-mode structure of collisional drift waves in Q machines due to the presence

of end plates. The two-fluid equations for electrons and ions are employed, including the effects of electron temperature perturbations and electron heat flow. Particular emphasis is placed on how a direct electron current along the magnetic field alters this structure. The dispersion relation and the sheath boundary condition resulting from both particle and heat flows are obtained. A slab-plasma model is adopted, with a uniform magnetic field perpendicular to both the density gradient and the end plates. The case where the electron flow velocity is comparable to the ion acoustic wave velocity is studied in detail. The dispersion relation indicates that the wave frequency and the temporal growth rate change only very little for devices with end plates. The normal model consists of two oppositely directed traveling drift waves and two small-amplitude oppositely directed traveling entropy waves. The drift waves grow spatially in the direction of electron flow and have a small axial phase shift, which varies linearly along the same direction. Good agreement is obtained with recent experimental results. (auth)

11216 INSTABILITIES AND INDUCED SCATTERING DUE TO NONLINEAR LANDAU DAMPING OF LONGITUDINAL PLASMA WAVES IN A MAGNETIC FIELD. Porkolab, M.; Chang, R. P. H. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 2, 283-96(Feb 1972).

The matrix elements for nonlinear wave–particle scattering (nonlinear Landau damping) are obtained in explicit form for electrostatic waves from the Vlasov–Maxwell equations. The waves are allowed to propagate at arbitrary angles to the magnetic field, and no restrictions are imposed upon the Larmor radius or the frequencies. In the case $k_\perp \gg k_\parallel$, the symmetry relations for mode–mode coupling are demonstrated by appropriate manipulations of the matrix elements. This allows one to cast the nonlinear Landau damping coefficients in a particularly simple form. The conditions for explosive instabilities are obtained, and a possible stabilization mechanism for these instabilities is pointed out. In the limit of either perpendicular or parallel propagation to the magnetic field, a comparison is made with previous results. The nonlinear stability of two types of velocity anisotropy instabilities are examined. Explosive instabilities are found to exist both for Harris modes and upper hybrid loss-cone modes. In addition, recent experimental results on nonlinear decay (induced scattering) of waves are discussed in the light of the present theory. (auth)

11217 EXPERIMENTAL STUDIES OF NONLINEAR LANDAU DAMPING AND GROWTH OF PLASMA WAVES IN A MAGNETIC FIELD. Chang, R. P. H.; Porkolab, M. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 2, 297-303(Feb 1972).

The nonlinear Landau damping and growth of longitudinal waves in a magnetic field is studied experimentally. It is observed that a finite-amplitude cyclotron harmonic wave may decay nonresonantly into a similar, small-amplitude wave. This perturbed wave can be amplified exponentially by increasing the amplitude of the finite-amplitude wave. Similarly, an externally launched small-amplitude test wave, having the same frequency as the perturbed wave, can be amplified at a comparable rate. The spatial growth of the test wave is in agreement with the predictions of a third-order mode-coupling equation. Using a calibrated interferometer system, the nonlinear Landau damping coupling coefficients (matrix elements) are measured quantitatively, and are found to be in good agreement with theory. (auth)

11218 FORMATION AND INTERACTION OF ION-ACOUSTIC SOLITARY WAVES IN A COLLISIONLESS WARM PLASMA. Sakanaka, P. H. (Columbia Univ., N. Y.). Phys. Fluids; 15: No. 2, 304-10(Feb 1972).

The formation and interaction of solitary waves in a warm-ion, hot isothermal electron plasma are studied with the Vlasov equation for ions and Boltzmann distribution for electrons. An arbitrary initial potential pulse having a width smaller (or larger) than that of a solitary wave decomposes into one (or several) solitary wave(s) with (or without) ion-acoustic oscillations behind. In the interaction of two solitary waves, it is found that: (1) if the initial amplitude ratio is not too large, the two waves exchange their amplitudes and bounce apart; (2) if the initial amplitude ratio is large, the larger wave first absorbs the smaller, subsequently re-emits it behind. A steady-state solitary wave solution for the ion fluid equations with a scalar pressure and Boltzmann electrons presents a smaller width and a larger velocity than the solution of the Korteweg–de Vries equation with the same amplitude. The limiting Mach number is smaller than Sagdeev's value. (auth)

11219 EXCITATION OF MOVING STRIATIONS BY A HIGH-FREQUENCY PLASMA RESONANCE. Peyre-Constantin, A. (Faculte des Sciences, Orsay, France). Phys. Lett.; 37A: No. 5, 463-4(20 Dec 1971).

Moving striations were produced by exciting a Tonks–Dattner or the main dipole resonance. The amplitude of the wave is practically proportional to the slope of the curve of the absorbed hf power versus the discharge current. The slope must be negative for the main dipole resonance, and positive for the first Tonks–Dattner. (auth)

11220 EXPERIMENTAL AND THEORETICAL STUDY OF A RESONANTLY SUSTAINED PLASMA IN MICROWAVE CAVITIES. Fredericks, Robert Michael. East Lansing, Mich.; Michigan State Univ. (1971). 238p. University Microfilms Order No. 71-31,201.

Thesis.

An experimental and theoretical investigation of re-entrant and cylindrical microwave cavity–plasma systems is performed. Using the linearized warm electron and cold ion plasma equations, along with Maxwell's equations, the axially propagating modes in two cylindrical waveguiding structures are analyzed. Both low-frequency ($\omega \sim \omega_i$) and high-frequency ($\omega \sim \omega_e$) solutions are presented. This bounded plasma theory is employed to interpret some low-frequency parametric instabilities observed in cylindrical plasma resonators. (TSS) (Diss. Abstr. Int., B)

11221 SPATIAL DAMPING OF LARGE-AMPLITUDE WAVES AND ION-WAVE TRAPPED-PARTICLE INSTABILITY. Lee, Anthony. Hoboken, N. J.; Stevens Inst. of Tech. (1971). 69p. University Microfilms Order No. 72-1622.

Thesis.

The spatial damping of a large-amplitude plasma wave was studied to permit direct comparison with experimental data. Using both the quasi-linear treatment of Al'tshul and Karpman and following exact particle trajectories of resonant particles as done by O'Neil for the temporal case, it was found that the spatial results are analogous to the temporal ones. The spatial damping formula is obtained by replacing the nondimensional time t/τ and the linear damping coefficient $\gamma_L \tau$ for the temporal case by the distance X/L and the linear spatial damping $\Lambda_L L$, respectively. Here, $\tau = (meEk)^{1/2}$, γ_L is the linear Landau damping coefficient, $\Lambda_L = \gamma_L/(\partial\omega/\partial k)$, and $L = \tau\omega/k$. Damping curves were plotted for comparison with measured data. The validity condition of the spatial case, i.e., $\Lambda_L L \ll 1$, is far more stringent than for the temporal one. An ion-wave trapped-particle instability is studied. The investigation involves using the bunched-beam oscillator model for the ions trapped by a large-amplitude ion acoustic mode to investigate instabilities as a consequence of the presence of trapped ions. For reasonable experimental plasma parameters, the theory predicts unstable ion waves with maximum growth rate of the order $0.01\omega_{pi}$ and frequency near $\omega_{pi}/2$ for the case $\omega_o \sim \omega_{pi}/5$, where ω_o is the frequency of the large-amplitude ion wave. The predicted instability may be a useful mechanism for spreading of the ion-wave spectrum and ion heating. (auth)

11222 NONSTATIONARY BEHAVIOR OF COLLISIONLESS SHOCKS. Morse, D. L.; Destler, W. W.; Auer, P. L. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 28: No. 1, 13-16 (3 Jan 1972).

Laboratory measurements indicate that a collisionless shock wave formed in a plasma-wind-tunnel device is nonstationary on the time scale of the ion gyroperiod. This behavior suggests a possible interpretation of recent data on magnetic field structure in the vicinity of Earth's bow shock. Comparison is made between the laboratory measurements and earlier computer simulations in which ion gyromotion was included. (auth)

11223 NON-LINEAR INSTABILITIES IN STREAMING PLASMAS. Stenflo, L. (Inst. of Physics, Umea, Sweden); Wilhelmsson, H.; Oestberg, K. Phys. Scr.; 3: No. 5, 231-2(1971).

A theory for numerical investigation of the nonlinear interaction of three electrostatic plasma waves is presented. (auth) (Sweden)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 9073, 9487, 9712, and 9821.

11224 (FIND-50244(12-71)) FIND: ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Smith, James G. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 10 Dec 1971. 21p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

11225 (WCAP-7765) WESTINGHOUSE PWR INTERNALS VIBRATION SUMMARY, 3-LOOP INTERNALS ASSURANCE. Kuenzel, A. J. (Westinghouse Electric Corp., Pittsburgh, Pa.). Sep 1971. 47p. Dep. NTIS.

Problems with the integrity of internal structures were observed in the Yankee, SELNI, SENA, and Obrigheim reactors. Model tests and static and dynamic tests were conducted to understand the problem mathematically and to predict behavior of components. Instrumentation programs at operating reactors measured vibrations of core structures. The problem was identified as caused by early thermal shield designs. New designs for the standard 3-loop plant include a one-piece thermal shield attached at both ends, which eliminates the vibration problem. (H.D.R.)

11226 FUTURE ASPECT OF NUCLEAR POWER IN FEDERAL REPUBLIC OF GERMANY. Throm, Wilhelm. Elektrotech. Z.,B; 23: No. 19, 454-7 (Sep 1971). (In German).

Operation and Economics

11227 (DOCKET-1155-147) LA CROSSE BOILING WATER REACTOR. In-Core Flux Detector. (Dairyland Power Cooperative, La Crosse, Wis.). 13 Dec 1971. 2p. Dep. NTIS.

11228 (DOCKET-1155-148) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, October 1971. (Dairyland Power Cooperative, La Crosse, Wis.). 6 Jan 1972. 35p. (DPC-851-36). Dep. NTIS.

11229 (DOCKET-50010-99) DRESDEN NUCLEAR POWER STATION, UNIT 1. Monitoring Relay Failure. (Commonwealth Edison Co., Chicago, Ill.). 8 Dec 1971. 2p. Dep. NTIS.

11230 (DOCKET-50016-138) ENRICO FERMI ATOMIC POWER PLANT. Report for September 1971. (Power Reactor Development Co., Detroit, Mich.). 29 Dec 1971. 14p. (PRDC-EF-97). Dep. NTIS.

11231 (DOCKET-50029-161) YANKEE NUCLEAR POWER STATION. Operation Report No. 131, November 1971. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Dec 1971. 9p. Dep. NTIS.

11232 (DOCKET-50146-101) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Accidental Release of Small Quantity of Radioactive Gases. (Saxton Nuclear Experimental Corp., Pa.). 28 Dec 1971. 2p. Dep. NTIS.

11233 (DOCKET-50155-95) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change No. 27. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Dec 1971. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the use of two PuO_2-UO_2 Type J-2 fuel assemblies in the core. (D.C.C.)

11234 (DOCKET-50206-137) SAN ONOFRE NUCLEAR GENERATING STATION. Operating Report, August 1971. (Southern California Edison Co., Los Angeles). 7p. (NYO-3270-53). Dep. NTIS.

11235 (DOCKET-50213-126) HADDAM NECK PLANT. Cooldown Transient, October 12, 1970. (Connecticut Yankee Atomic Power Co., Hartford). 29 Dec 1971. 4p. Dep. NTIS.

11236 (DOCKET-50213-127) HADDAM NECK PLANT. Title I and Title II, Design and Engineering. Annual Report, July 1964-June 1965. (Connecticut Yankee Atomic Power Co., Haddam). Jun 1965. 77p. (NYO-3250-4). Dep. NTIS.

11237 (DOCKET-50219-156) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Loss of Station Air System. (Jersey Central Power and Light Co., Morristown, N. J.). 17 Dec 1971. 2p. Dep. NTIS.

11238 (DOCKET-50219-157) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Radwaste Outside Tank Activity. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Dec 1971. 2p. Dep. NTIS.

11239 (DOCKET-50219-159) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Trip of Diesel Generator No. 1 During Surveillance Test. (Jersey Central Power and Light Co., Morristown, N. J.). 5 Jan 1972. 2p. Dep. NTIS.

11240 (DOCKET-50219-160) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Failure of Isolation Condenser Vent Line. (Jersey Central Power and Light Co., Morristown, N. J.). 12 Jan 1972. 2p. Dep. NTIS.

11241 (DOCKET-50220-75) NINE MILE POINT NUCLEAR STATION. Valve Seats Cracked. (Niagara Mohawk Power Corp., Lycoming, N. Y.). 13 Dec 1971. 1p. Dep. NTIS.

Information is presented concerning the cracked by-pass valve seats of the turbine. Corrective actions are described. (D.C.C.)

11242 (DOCKET-50220-76) NINE MILE POINT NUCLEAR STATION. Stress Corrosion Cracking of Heavily Sensitized Materials. (Niagara Mohawk Power Corp., Lycoming, N. Y.). 13 Dec 1971. 2p. Dep. NTIS.

11243 (DOCKET-50220-77) NINE MILE POINT NUCLEAR STATION. Tests Performed at 1850 MW(t). (Niagara Mohawk Power Corp., Syracuse, N. Y.). 15 Dec 1971. 3p. Dep. NTIS.

11244 (DOCKET-50237-209) DRESDEN NUCLEAR POWER STATION, UNIT 2. Main Steam Line Hi-Flow Isolation Switch Inoperable. (Commonwealth Edison Co., Chicago, Ill.). 5 Jan 1972. 2p. Dep. NTIS.

11245 (DOCKET-50249-113) DRESDEN NUCLEAR POWER STATION, UNIT 3. Failure of Pressure Suppression Chamber to Reactor Building Vacuum Breaker. (Commonwealth Edison Co., Chicago, Ill.). 23 Dec 1971. 2p. Dep. NTIS.

11246 (DOCKET-50249-114) DRESDEN NUCLEAR POWER STATION, UNIT 3. Mechanical Vacuum Pump Suction Valve Failed to Close. (Commonwealth Edison Co., Chicago, Ill.). 7 Jan 1972. 1p. Dep. NTIS.

11247 (DOCKET-50250-58) TURKEY POINT PLANT, UNIT 3. Main Steam Line 3A Relief Valve Header Failure. (Division of Compliance (AEC), Atlanta, Ga. Region II). 12 Jan 1972. 3p. Dep. NTIS.

11248 (DOCKET-50255-62) PALISADES PLANT. Control Rod Drive Mechanism Not Consistently Responsive to Control Signals. (Consumers Power Co., Jackson, Mich.). 30 Dec 1971. 2p. Dep. NTIS.

11249 (DOCKET-50255-63) PALISADES PLANT. Shearing of Small Drain Line from Atmospheric Steam Dump Header. (Consumers Power Co., Jackson, Mich.). 7 Jan 1972. 3p. Dep. NTIS.

11250 (DOCKET-50263-95) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Failure of ECCS Valve Opening Permissive Switch. (Northern States Power Co., Minneapolis, Minn.). 21 Dec 1971. 1p. Dep. NTIS.

11251 (DOCKET-50263-96) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Failure of ECCS Pump Start Permissive Switch and Relay. (Northern States Power Co., Minneapolis, Minn.). 20 Dec 1971. 2p. Dep. NTIS.

11252 (DOCKET-50263-98) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Steps Taken to Correct Items Which Appeared to be in Noncompliance. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 16 Dec 1971. 4p. Dep. NTIS.

Revised operating procedures are described including the reset sequence for Group 1 and Group 3 isolation valves. (D.C.C.)

11253 (DOCKET-50263-99) MONTICELLO NUCLEAR GENERATING PLANT. Main Steam Line Flow Element Response. (Northern States Power Co., Minneapolis, Minn.). 10 Jan 1972. 1p. Dep. NTIS.

11254 (DOCKET-50280-62) SURRY POWER STATION, UNITS 1 AND 2. Preoperational Environmental Radiation Surveillance Program, July 1, 1970-June 30, 1971. (Virginia Electric and Power Co., Richmond). 29 Dec 1971. 110p. (DOCKET-50281-58). Dep. NTIS.

11255 (EUR-4705) ARDENNES NUCLEAR POWER PLANT. Annual Report, 1970. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 14 Jul 1971. 40p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 6,65.

The Ardennes nuclear power plant resumed service in March 1970 after a two-year shut-down due to damage to the reactor internals. It subsequently operated under very satisfactory conditions, in general, apart from about a month's outage due to an accident to the main power output transformer. With a production of 1,233 million kWh at a cost of 6.92 French centimes, 1970 is accordingly the plant's first year of actual industrial service. (auth)

11256 (TID-25881) GARIGLIANO NUCLEAR POWER STATION. Operation Report for the Second Quarter of 1971. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 30 Jun 1971. 16p. Dep. NTIS.

Failure of reactor recirculation pump A conditioned the station output for the whole second quarter in 1971, limiting it to 150 MW(e) gross, with an availability factor of 67.2% and a capacity factor of 64.1%. The lack of generation in April 1971 was caused by a station personnel strike and by a power reduction to 143 MW(e) following an outage of heater No. 2. From 14 May to 6 June the station was placed out of service for inspections on the above-mentioned reactor recirculation pump and for repair of heater No. 2 leak. On 26 May the pump was cut out of the circuit and a blank flange was installed in order to resume operation with the A leg in natural circulation. The pump is being decontaminated prior to the general overhaul to establish the extent of the damage and the necessary repairs. (auth)

11257 (TID-25884) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, September 1971. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 20 Oct 1971. 38p. (In German). Dep. NTIS.

The plant was operated throughout the month at full load without breakdown. On 26 September there was a brief reduction of load to change the control rod withdrawal sequence, to carry out some necessary routine tests and to repair a steam leak. The activities in the reactor water and off-gas are still low. (auth)

Safety and Siting

Refer also to abstract 9536.

11258 (DOCKET-1151-49) ELK RIVER REACTOR. Technical Specifications, Change Request No. 16. (Rural Cooperative Power Association, Elk River, Minn.). 17 Dec 1971. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the construction of an access hatch and an additional opening in the containment building wall to aid in dismantling the reactor. (D.C.C.)

11259 (DOCKET-50010-100) DRESDEN NUCLEAR POWER STATION, UNIT 1. Augmented In-Service Inspection. (Commonwealth Edison Co., Chicago, Ill.). 29 Dec 1971. 6p. Dep. NTIS.

11260 (DOCKET-50016-137) ENRICO FERMI ATOMIC POWER PLANT. Preliminary Report of Possible Sodium System Leak. (Power Reactor Development Co., Detroit, Mich.). 20 Dec 1971. 8p. Dep. NTIS.

11261 (DOCKET-50133-69) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Technical Specifications, Addendum A to Proposed Change No. 36. (Pacific Gas and Electric Co., San Francisco, Calif.). 29 Dec 1971. 4p. Dep. NTIS.

Revised technical specifications are presented concerning leak detection devices for the primary cooling system and a dry well leakage rate limit of 1.0 gallon per minute. (D.C.C.)

11262 (DOCKET-50133-70) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Technical Specifications, Proposed Change No. 37. (Pacific Gas and Electric Co., San Francisco, Calif.). 29 Dec 1971. 6p. Dep. NTIS.

Revised technical specifications are presented concerning the addition of a high dry well lower head level permissive in the automatic initiation circuitry of the reactor vent valves. The modification will reduce the possibility of spurious vent valve actuation under loss of power conditions. (D.C.C.)

11263 (DOCKET-50133-71) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Emergency Core Cooling System Conformance to New AEC Adopted Interim Acceptance Criteria. (Pacific Gas and Electric Co., San Francisco, Calif.). 31 Dec 1971. 31p. Dep. NTIS.

11264 (DOCKET-50146-102) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Technical Specifications, Change No. 49. (Division of Reactor Licensing (AEC), Washington, D. C.). 15 Dec 1971. 2p. Dep. NTIS.

Revised technical specifications are presented concerning leak rate limits for the primary cooling system. (D.C.C.)

11265 (DOCKET-50155-96) BIG ROCK POINT NUCLEAR PLANT. Loss of Coolant Accident Analysis. (Consumers Power Co., Jackson, Mich.). 30 Dec 1971. 25p. Dep. NTIS.

11266 (DOCKET-50171-95) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Moisture Detectors. (Philadelphia Electric Co., Pa.). 7 Jan 1972. 2p. Dep. NTIS.

Replacement of moisture detectors in the protection system due to excessive response times is described. (D.C.C.)

11267 (DOCKET-50206-136) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Emergency Core Cooling Performance. (Southern California Edison Co., Rosemead, Calif.). 29 Dec 1971. 66p. Dep. NTIS.

11268 (DOCKET-50213-125) HADDAM NECK PLANT. Emergency Core Cooling Performance. (Connecticut Yankee Atomic Power Co., Hartford). 30 Dec 1971. 61p. Dep. NTIS.

11269 (DOCKET-50219-158) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operating License DPR-16, Change Request No. 10. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Dec 1971. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the storage of liquid radioactive waste at the reactor site. (D.C.C.)

11270 (DOCKET-50245-109) MILLSTONE NUCLEAR POWER STATION, UNIT NO. 1. Technical Specifications, Proposed Change No. 2. (Millstone Point Co., Hartford, Conn.). 23 Dec 1971. 14p. Dep. NTIS.

Revised technical specifications are presented concerning the performance requirements of the emergency service water system pumps. (D.C.C.)

11271 (DOCKET-50245-110) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Plant Design Change Request No. PORC 51-71. (Millstone Point Co., Hartford, Conn.). 30 Dec 1971. 3p. Dep. NTIS.

Revised design parameters are presented concerning the addition of an extra pressure control valve on the core spray and low pressure coolant injection system "keep fill" lines. (D.C.C.)

11272 (DOCKET-50247-55) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Design Drawing of the Electrical Splice Boxes. (Consolidated Edison Co. of New York, Inc., New York). 20 Dec 1971. 1p. Dep. NTIS.

11273 (DOCKET-50250-56) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Revision 20. (Florida Power and Light Co.). 21 Dec 1971. 78p. (DOCKET-50251-51). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

11274 (DOCKET-50250-57) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Revision 21. (Florida Power and Light Co.). 30 Dec 1971. 69p. (DOCKET-50251-52). Dep. NTIS.

Revised technical specifications are presented. (D.C.C.)

11275 (DOCKET-50250-59) TURKEY POINT PLANT, UNITS 3 AND 4. Quality Control and Acceptability of Valves. (Florida Power Corp., St. Petersburg). 16 Dec 1971. 7p. (DOCKET-50251-53). Dep. NTIS.

11276 (DOCKET-50254-61) QUAD-CITIES STATION, UNITS 1 AND 2. Environmental Report, Supplement No. 4. (Commonwealth Edison Co., Chicago, Ill.). 4 Jan 1971. 41p. (DOCKET-50265-53). Dep. NTIS.

Additional information is presented concerning the use of a closed cycle spray canal to dissipate thermal discharges from the reactor. (D.C.C.)

11277 (DOCKET-50261-82) H. B. ROBINSON UNIT NO. 2. Third Failure of a Sample Heat Exchanger. (Carolina Power and Light Co., Raleigh, N. C.). 21 Dec 1971. 1p. Dep. NTIS.

11278 (DOCKET-50263-97) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Modifications to Main Steam Flow Element Throat Pressure Taps. (Northern States Power Co., Minneapolis, Minn.). 28 Dec 1971. 2p. Dep. NTIS.

11279 (DOCKET-50266-58) POINT BEACH NUCLEAR PLANT, UNITS NO. 1 AND NO. 2. Technical Specifications, Amendment 2.

(Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Jul 1971. 177p. (DOCKET-50301-47). Dep. NTIS.

11280 (DOCKET-50269-45) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Reply to Letter on Comments from U. S. Department of Interior, Fish and Wildlife Service. (Duke Power Co., Charlotte, N. C.). 23 Dec 1971. 2p. (DOCKET-50270-38; DOCKET-50287-35). Dep. NTIS.

Additional information is presented concerning the monitoring of ecosystems for radionuclides from the reactors' radioactive effluents. (D.C.C.)

11281 (DOCKET-50271-67) VERMONT YANKEE NUCLEAR POWER STATION. Supplement to Environmental Report, Volume I. (Vermont Yankee Nuclear Power Corp., Rutland). 21 Dec 1971. 257p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11282 (DOCKET-50271-68) VERMONT YANKEE NUCLEAR POWER STATION. Supplement to Environmental Report, Volume II. (Vermont Yankee Nuclear Power Corp., Rutland). 21 Dec 1971. 341p. Dep. NTIS.

Information concerning chemical and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological studies of the Connecticut River are included. (D.C.C.)

11283 (DOCKET-50277-41) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment No. 13. (Philadelphia Electric Co., Pa.). 23 Dec 1971. 46p. (DOCKET-50278-31). Dep. NTIS.

Information is presented concerning safety valves and the pressure vessel overpressure protection system. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11284 (DOCKET-50280-61) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 30. (Virginia Electric and Power Co., Richmond). 29 Dec 1971. 236p. (DOCKET-50281-57). Dep. NTIS.

Revised design parameters of the Surry Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11285 (DOCKET-50280-63) SURRY POWER STATION, UNITS 1 AND 2. Effect of Fissuring on Welds in Elevated Temperature Service. (Stone and Webster Engineering Corp., Boston, Mass.). 6 Aug 1971; Revised 10 Dec 1971. 61p. (DOCKET-50281-59; SW-MER-2-a). Dep. NTIS.
For Virginia Electric and Power Co., Richmond.

11286 (DOCKET-50280-64) SURRY POWER STATION, UNITS 1 AND 2. Response to Comments by Fish and Wildlife Service. (Virginia Electric and Power Co., Richmond). 3 Jan 1972. 5p. (DOCKET-50281-60). Dep. NTIS.

Additional information is presented concerning radioactive and thermal effluents from the reactor and protection measures established for ecosystems. (D.C.C.)

11287 (DOCKET-50282-46) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 14, Volume 6. (Northern States Power Co., Minneapolis, Minn.). 10 Jan 1972. 147p. (DOCKET-50306-45). Dep. NTIS.

Revised design parameters of the Prairie Island Power Reactor Units 1 and 2 are presented. Performance evaluation of the emergency core cooling system is included. (D.C.C.)

11288 (DOCKET-50285-53) FORT CALHOUN STATION, UNIT NO. 1. Final Safety Analysis Report, Supplement No. 14. (Omaha Public Power District, Nebr.). 30 Dec 1971. 55p. Dep. NTIS.

Revised design parameters of the Fort Calhoun Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11289 (DOCKET-50289-45) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Supplementary Statement of Facts Relating to Transmission Lines. (Metropolitan Edison Co., Reading, Pa.). 28 Dec 1971. 224p. (DOCKET-50320-27). Dep. NTIS.

11290 (DOCKET-50293-63) PILGRIM NUCLEAR POWER STATION. Preoperational Environmental Radiation Survey Program. Quarterly Report, July 1-September 30, 1971. (ICN/Tracerlab, Waltham, Mass.). 7 Jan 1972. 37p. Dep. NTIS.
For Boston Edison Co., Mass.

11291 (DOCKET-50295-36) ZION STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 18. (Commonwealth Edison Co., Chicago, Ill.). 30 Dec 1971. 324p. (DOCKET-50304-3[illegible]). Dep. NTIS.

Revised design parameters of the Zion Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

11292 (DOCKET-50302-31) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Environmental Report, Operating License Stage, Volume 1. (Florida Power Corp., St. Petersburg). 4 Jan 1972. 192p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, geological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

11293 (DOCKET-50302-32) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Environmental Report, Operating License Stage, Volume 2. (Florida Power Corp., St. Petersburg). 4 Jan 1972. 241p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11294 (DOCKET-50302-33) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Environmental Report, Operating License Stage, Volume 3. (Florida Power Corp., St. Petersburg). 4 Jan 1972. 217p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11295 (DOCKET-50305-32) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment No. 14. (Wisconsin Public Service Corp., Green Bay). 4 Jan 1972. 557p. Dep. NTIS.

Revised design parameters of the Kewaunee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11296 (DOCKET-50309-46) MAINE YANKEE ATOMIC POWER STATION. Final Safety Analysis Report, Amendment No. 34. (Maine Yankee Atomic Power Co., Westboro, Mass.). 20 Dec 1971. 92p. Dep. NTIS.

Revised design parameters of the Maine Yankee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11297 (DOCKET-50317-33) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 16. (Baltimore Gas and Electric Co., Md.). 30 Dec 1971. 297p. (DOCKET-50318-33). Dep. NTIS.

Revised design parameters of the Calvert Cliffs Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

11298 (DOCKET-50317-34) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Chemical Discharges from the Plant. (Baltimore Gas and Electric Co., Md.). 22 Nov 1971. 3p. (DOCKET-50318-34). Dep. NTIS.

11299 (DOCKET-50322-22) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Environmental Report, Construction Permit Stage. (Long Island Lighting Co., Hicksville, N. Y.). 29 Dec 1971. 439p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

11300 (DOCKET-50322-23) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Environmental Report, Construction Permit Stage, Appendices. (Long Island Lighting Co., Mineola, N. Y.). [1971]. 834p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

11301 (DOCKET-50324-30) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Design Reports Nos. 9 and 10, Seismic

Analyses, Control and Radwaste Buildings. (Carolina Power and Light Co., Raleigh, N. C.). 22 Dec 1971. 103p. (DOCKET-50325-30). Dep. NTIS.

11302 (DOCKET-50324-31) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Design Report No. 11, Volume 1. Containment Large Opening Design: Test and Figures. (Carolina Power and Light Co., Raleigh, N. C.). 31 Dec 1971. 153p. (DOCKET-50325-31). Dep. NTIS.

11303 (DOCKET-50324-32) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Design Report No. 11, Volume 2. Containment Large Opening Design: Stress Plots. (Carolina Power and Light Co., Raleigh, N. C.). 31 Dec 1971. 388p. (DOCKET-50325-32). Dep. NTIS.

11304 (DOCKET-50327-22) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Independent Analysis Program of Ice Condenser Containment. (Tennessee Valley Authority, Chattanooga). 30 Dec 1971. 6p. (DOCKET-50328-22). Dep. NTIS.

11305 (DOCKET-50329-28) MIDLAND PLANT, UNITS 1 AND 2. Draft Detailed Statement on Environmental Considerations Related to Issuance of a Construction Permit. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). 7 Jan 1972. 138p. (DOCKET-50330-27). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11306 (DOCKET-50334-28) BEAVER VALLEY POWER STATION, UNIT 1. Environmental Report, Operating License Stage, Amendment 1. (Duquesne Light Co., Pittsburgh, Pa.). 5 Jan 1972. 136p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11307 (DOCKET-50335-23) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Environmental Report, Supplement. (Florida Power and Light Co.). 6 Jan 1972. 57p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is described. The effects of reactor operations on the environment are analyzed. Environmental aspects of transmission lines are described. (D.C.C.)

11308 (DOCKET-50335-24) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment No. 11. (Florida Power and Light Co.). 7 Jan 1972. 46p. Dep. NTIS.

Requested additional information is presented concerning the dynamic design analysis of Class 1 equipment. (D.C.C.)

11309 (DOCKET-50336-31) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment No. 12. (Millstone Point Co., Hartford, Conn.). 23 Dec 1971. 15p. Dep. NTIS.

Requested additional information is presented on design parameters and operations aspects of the reactor. (D.C.C.)

11310 (DOCKET-50338-34) NORTH ANNA POWER STATION, UNITS 1 AND 2. Request to Continue Construction of Offsite Transmission Line Facilities. (Virginia Electric and Power Co., Richmond). 27 Dec 1971. 18p. (DOCKET-50339-33). Dep. NTIS.

11311 (DOCKET-50341-36) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Environmental Report, Revised Pages and Supplement I. (Detroit Edison Co., Mich.). 13 Jan 1972. 12p. Dep. NTIS.

Revised information is presented concerning chemical, radioactive, and thermal discharges from the reactor. Also included are revised data on transmission lines. (D.C.C.)

11312 (DOCKET-50348-31) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preoperational Environmental Study. (Alabama Power Co., Birmingham). 20 Dec 1971. 217p. (DOCKET-50364-25). Dep. NTIS.

Chemical compositions of water, sediment, and biological samples from the reactor site are presented. (D.C.C.)

11313 (DOCKET-50348-32) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Dec 1971. 181p. (DOCKET-50364-26). Dep. NTIS.

11314 (DOCKET-50358-30) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Environmental Report, Supplement No. 2. (Cincinnati Gas and Electric Co., Ohio). 29 Dec 1971. 197p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11315 (DOCKET-50361-19) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Environmental Report, Construction Permit Stage, Supplement, Volume 1. (Southern California Edison Co., Rosemead, Calif.). 22 Dec 1971. 450p. (DOCKET-50362-18). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, geological, hydrological, and meteorological data for the reactor site are included. Environmental aspects of transmission lines are described. (D.C.C.)

11316 (DOCKET-50361-20) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Environmental Report, Construction Permit Stage, Supplement, Volume 2. (Southern California Edison Co., Rosemead, Calif.). 22 Dec 1971. 438p. (DOCKET-50362-19). Dep. NTIS.

Information concerning the radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11317 (DOCKET-50366-21) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Reasons Why Exemptions Should be Granted to Allow Certain Activities. (Georgia Power Co., Atlanta). 28 Dec 1971. 27p. Dep. NTIS.

11318 (DOCKET-50367-26) BAILLY GENERATING STATION, NUCLEAR I. Environmental Report, Amendment No. 2. (Northern Indiana Public Service Co., Hammond). 10 Jan 1972. 31p. Dep. NTIS.

Revised and additional data are presented concerning chemical, radioactive, and thermal discharges from the reactor. The effects of reactor operations on the environment are analyzed. (D.C.C.)

11319 (DOCKET-50369-18) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Independent Analysis Program of Ice Condenser Containment. (Duke Power Co., Charlotte, N. C.). 23 Dec 1971. 6p. (DOCKET-50370-17). Dep. NTIS.

11320 (DOCKET-50382-14) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment No. 8. (Louisiana Power and Light Co., New Orleans). 14 Dec 1971. 111p. Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Unit 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11321 (DOCKET-50382-15) WATERFORD STEAM ELECTRIC STATION, UNIT NO. 3. Preliminary Safety Analysis Report, Amendment No. 9. (Louisiana Power and Light Co., New Orleans). 7 Jan 1972. 235p. Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Unit 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11322 (DOCKET-50395-13) VIRGIL C. SUMMER NUCLEAR STATION. Preliminary Safety Analysis Report, Amendment No. 4. (South Carolina Electric and Gas Co., Columbia). 23 Dec 1971. 478p. Dep. NTIS.

Revised design parameters of the Virgil C. Summer Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

11323 (NP-19120) DISTRIBUTION OF COOLING WATER IN OEREGRUNDSGREPEN. REPORT ON EXPERIMENTS WITH MODELS, APRIL-June 1971. (Swedish State Power Board, Alvkarleby, Hydraulic Lab.). Jul 1971. 198p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Model experiments are described for finding the most suitable performance and location of the paths of cooling water at the planned nuclear power station at Forsmark in Sweden. The purpose was to obtain a solution which permitted building of an extensible plant with the smallest possible temperature increase in the surroundings. Fifty-five experiments are performed in scale 1:350 (horizontal) and 1:50 (vertical). (Sweden)

11324 (WCAP-7742) IODINE REMOVAL BY SPRAY IN THE ZION STATION CONTAINMENT. Pasedag, W. F. (Westinghouse Electric Corp., Pittsburgh, Pa.). Aug 1971. 78p.

A comprehensive mathematical model is developed to describe the absorption of elemental iodine vapor from the containment atmosphere by the containment spray system. Specifically, this model includes the effects of the complete spectrum of drop sizes emitted by the containment spray nozzles, condensation of steam on the spray drops, coalescence of drops, and the mass transfer resis-

tance in the liquid phase of the drops. The model is shown to be conservative by theoretical considerations in the derivation, by comparison with alternate models, and by comparison with experimental data. The model is then applied to the Zion Station containment. Minimum performance values are used for all parameters which enter the analysis. This evaluation of the iodine removal effectiveness of the containment spray system gives an exponential removal coefficient, λ_1, of 68/hr. Although this value represents a conservative evaluation of the spray system under the most adverse conditions, a design value of $\lambda_s = 54$/hr is established by adding additional safety margins to the input parameter 47 references. (auth)

11325 PRINCIPLES OF SETTING LIMITS FOR RADIOACTIVE PRODUCT RELEASE FROM STACKS OF ATOMIC INDUSTRY AND POWER PLANTS. Artemova, N. E.; Teverovskii, E. N. At. Energ. (USSR); 31: No. 6, 573-6(Dec 1971). (In Russian).

The general estimate scheme of minimum average annual dilution coefficient of radioactive mixture permanently discharged from the stacks into the lowest atmosphere is considered. The corrections for peculiarities of real dilution are discussed. 11 references. (auth)

Power Reactor Development

Refer also to abstracts 9721, 9762, 9824, and 9838.

11326 (BNWL-1522-4) AEC REACTOR DEVELOPMENT AND TECHNOLOGY PROGRAMS. Technical Activities Quarterly Report, July-September 1971. (Battelle Pacific Northwest Labs., Richland, Wash.). Dec 1971. Contract AT(45-1)-1830. 35p. Dep. NTIS.

CARBON DIOXIDES—yields from radiolysis of carbon monoxide, water vapor, and helium mixtures, (E)
CARBON MONOXIDES—CO-H_2O-He, radiolysis of, yields of carbon dioxide and hydrogen from, (E)
HELIUM—CO-H_2O-He, radiolysis of, yields of carbon dioxide and hydrogen from, (E)
HIGH TEMPERATURE LATTICE TEST REACTOR—physics measurements on mockup MSBR and HTGR-type lattices in
HYDROGEN—yields from radiolysis of carbon monoxide, water vapor, and helium mixtures, (E)
MATERIALS TESTING REACTOR—fuel plates for Phoenix core in, isotopic analysis of irradiated, (E)
MOLTEN SALT BREEDER REACTOR—multiplication factors for mockup lattice of, infinite medium, (E/T)
PLUTONIUM 241—effects on criticality safety limits for plutonium nitrate solutions, (E)
PLUTONIUM NITRATES—criticality of solutions of, effects of plutonium isotope concentrations on, (E)
REACTOR FUEL ELEMENTS—performance of rod bundle, development of COBRA code for prediction of thermal-hydraulic
REACTORS, GAS COOLED—physics parameters of thorium oxide (ThO_2)-plutonium oxide (PuO_2) fueled high temperature, (E/T)
—cooling systems of graphite moderated, radiolytic reactions in, (E)
REACTORS, GRAPHITE MODERATED—cooling systems of helium cooled, radiolytic reactions in, (E)
WATER VAPOR—CO-H_2O-He, radiolysis of, yields of carbon dioxide and hydrogen from, (E) (H.D.R.)

11327 (KFK-1432) HEXAGON: A SYSTEM FOR TREATMENT OF PROBLEMS IN HEXAGONAL ARRANGEMENTS. Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jul 1971. 14p. (In German). Dep. NTIS (U. S. Sales Only).

Polar and Cartesian Coordinates are inadequate for the solution of technical problems in the hexagonal geometry of fast reactor cores. A consistent method for describing positions on the basis of regular hexagonal structures was developed, which is especially suitable for expressing neighborhood relationships between hexagons. A set of algorithms was developed, which allows effective storage of information about regular hexagonal structures in a linear array. The corresponding Fortran-routines are described. (auth)

11328 (NEIC-RR-43) PRESSURIZED WATER REACTORS. Bibliography, 1969-1970. Kowalski, A. (comp.) (Nuclear Energy Information Center, Warsaw (Poland)). 1971. 140p. Dep. NTIS (U. S. Sales Only).

Included are 1486 references on pressurized water reactors. The references were cited in Nuclear Science Abstracts in the period 1969 to 1970. A subject index and a reactors index are included. (H.D.R.)

11329 (RCN-137) FAST REACTOR PROGRAMME. Second Quarter 1970, Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Jan 1971. 82p. (EURFNR-900). Dep. NTIS (U. S. Sales Only).

The RCN program comprises reactor physics, fuel performance, radiation damage in canning materials, corrosion behavior of canning materials, aerosol research and heat transfer and hydraulics. (16 references) (auth) (Netherlands)

11330 (RCN-154) FAST REACTOR PROGRAMME. Fourth Quarter 1970 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Jul 1971. 75p. Dep. NTIS (U. S. Sales Only).

The RCN program comprises reactor physics, fuel performance, radiation damage in canning materials, corrosion behavior of canning materials, aerosol research and heat transfer and hydraulics. 13 references. (auth)

11331 REDUCTIONS IN WASTE HEAT EMISSIONS FROM A NUCLEAR POWER CYCLE BY OPTIMIZATION OF FEEDWATER HEATER CONDITIONS. Richard, Clyde Charles Jr. Storrs, Conn.; Univ. of Conneticut (1971). 170p. University Microfilms Order No. 71-29,903.

Thesis.

The minimum amount of heat rejection from a six and also a seven feedwater heater nuclear power cycle was determined. The minimum heat rejection was obtained by increasing feedwater heater heat transfer surface area. The minimum heat rejection was calculated for both 2.0 and 2.5 inch Hga exhaust condenser pressure. The analysis requires that the added cost associated with the addition of heat transfer area be offset by improved cycle operating performance. This criterion sets a limit to the increase in heater surface area which may be added. In order to determine the minimum amount of heat rejection, precise computer programs are presented for evaluating the performance of the nuclear power cycle and the feedwater heater surface area. A patterm search optimization technique was adapted and utilized to determine the conditions required for minimum heat rejection. The economic constraints of added heater cost were included in the optimization procedure. The results indicate that a reduction in the waste heat rejection from the condenser of a six feedwater heater nuclear power cycle of 15.5 BTU/hr per kilowatt of electrical output compared to a standard cycle is possible. Approximately the same decrease in heat rejection was obtained for both exhaust condenser pressures considered (2.0 and 2.5 inch Hga). For the seven feedwater heater cycle reductions in waste heat rejections of 14.9 and 9.5 BTU/hr per kilowatt of electrical output are found for the condenser pressures of 2.0 and 2.5 inch Hga, respectively. (Diss. Abstr. Int., B)

11332 GENEVA IV. A Report on the Fourth United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, September 6-16, 1971. Nucl. News; 14: No. 10X, 1-132(15 Oct 1971).

Papers presented at Geneva on developmental aspects of the atom and the applied research associated with them are summarized. Basic research is described, and research uses of reactors and accelerators, controlled thermonuclear reactions, the biological sciences, and the transuranium and super-heavy isotopes are discussed. Also included are papers on the regulation of nuclear energy, the education and training of nuclear scientists and technicians, the importance of the international exchange of information, and the need for public understanding of the atom. (H.D.R.)

11333 BREEDER REACTORS: POWER FOR THE FUTURE. Hammond, Allen L. Science; 174: No. 4011, 807-10(19 Nov 1971).

The development programs for fast breeder reactors in the U. S. are reviewed. The comparison of gas cooled and liquid metal cooled reactor concepts is presented. (D.C.C.)

11334 INTERLOCKED ASSEMBLY OF BLOCKS FOR A NUCLEAR REACTOR MODERATING CORE. Banks, Robert (to United Kingdom Atomic Energy Authority). British Patent 1,254,872. 24 Nov 1971. Filed 21 Mar 1968.

The structure described comprises superposed layers of moderator material, each layer being composed of parallel elongated bodies extending through the layer with elongated locking members located in interstices between the bodies. In this way columns of stacked bodies are formed, with the longitudinal axes of the columns perpendicular to the layers. Each body in the layers has at least three external splines arranged so that both side faces of each spline lie in planes passing through the longitudinal axis of the body, each locking mem-

ber having faces complementary to the side faces of the splines. The side faces of the splines of each body are in co-operating abutment with the corresponding side faces of neighboring bodies and with side faces of a locking member. The locking members preferably extend through two layers of moderating material, side faces of each locking member abutting side faces of splines on bodies in both layers. (UK)

11335 INTERNATIONAL NUCLEAR POWER. Davis, W. Kenneth (Bechtel Corp., San Francisco). J. Brit. Nucl. Energy Soc.; 10: No. 4, 269-78(Oct 1971).

The nuclear power industry is discussed, with emphasis on technical, management, and commercial considerations. Many diverse topics are considered, stress being laid on the following: the importance of international trade and cooperation particularly in the fields of fuel cycle services and plant components; the success of light water reactors and the status of fast breeder reactors; the use of systems analysis in selection of reactor types; problems involved in the introduction and development of new concepts. There are also comments on methods of carrying out nuclear plant projects and particularly on the role of the engineer-constructor. (UK)

Kinetics and Dynamics

11336 (BARC-550) NEUTRONICS STUDIES OF TWO 500-MWe Pu-Th AND ^{233}U-Th FAST BREEDER SYSTEMS. Shukla, V. K.; Garg, S. B. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 16p. Dep. NTIS (U. S. Sales Only).

The neutronics studies have been carried out for two 500 MW(e) fast breeder systems which utilize Pu-Th and ^{233}U-Th metal fuels. The fuel utilization characteristics such as breeding ratio, fuel inventory and doubling times have been calculated as a function of the blanket thickness and the core fuel concentration with a thin cladding. The coolant reactivity coefficient has also been calculated by removing uniformly 40% of sodium from the core. 5 references. (auth)

11337 EVALUATION OF SPACE-ENERGY FACTORIZATION FOR TWO-DIMENSIONAL DIFFUSION THEORY PROBLEMS IN THE LIQUID METAL FAST BREEDER REACTOR. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 46: No. 3, 421-5(Dec 1971).

The space-energy factorization scheme was applied to obtain solutions of the energy-dependent neutron diffusion equation for two-dimensional/24-group LMFBR models. It is shown that the SEF method provides an economical means for obtaining approximate solutions for the LMFBR problems. Further, the capability of multidimensional diffusion theory codes in solving 20- to 30-group LMFBR problems will be enhanced by providing for the SEF calculation. (auth)

11338 APPLICATION OF THE FAST FOURIER TRANSFORM ALGORITHM TO ON-LINE REACTOR DIAGNOSIS. Kryter, R. C. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 210-17(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The FFT computing algorithm, when implemented on a modern digital process computer, provides nearly realtime power spectrum analysis of noise signals. Programmable selection of frequency range, filter center frequencies, and bandwidths makes its use attractive for increasing the safety and availability of complex and expensive reactor systems through on-line monitoring of fluctuations in neutron or gamma flux, system pressure, or mechanical vibration. 22 references. (auth)

11339 REAL TIME DIGITAL SOLUTION OF POWER REACTOR KINETICS USING Z-TRANSFORMS. Czerniejewski, F. R. (Curtiss Wright Electronics, East Paterson, N. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 218-21(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Real time simulation for a multi-node, multi-delay group neutron kinetics model of power reactors has been achieved by application of the discrete interval Z-Transform method of Fowler together with a small correction on the stable period. These transforms are applied sequentially to the reactor kinetic equations to yield a set of linear algebraic difference equations which are accurate to one percent. Spatial variation is achieved by diffusion theory coupling terms between nodes. Several plots of analytic vs. simulated neutron density for single node cases are presented using a 10 Hertz solution rate. (auth)

Control Systems

Refer also to abstracts 9296, 9337, and 9441.

11340 TRIAL MANUFACTURE OF CONTROL ROD AND CONTROL ROD DRIVES. Kiryu, Kiyomi (Hitachi Ltd., Ibaraki, Japan). Karyoku Hatsuden; 22: No. 4, 419-24(Apr 1971). (In Japanese).

The trial manufacture of a BWR-type control rod and control rod drive and results of performance examination of trial products are described. Several tests were carried out concerning the control rod, such as mechanical performance including analysis of composition of materials, nondestructive material check, void check for completed material, and destructive testing. Tests were carried out for the control rod drive using a test facility simulating operating conditions of reactors. Operational characteristics at ambient temperature and high temperature were measured, including pressure difference between upper and lower sides of a piston and leakage from a carbon seal. Scram characteristics were examined at high temperature and compared with a product of the General Electric Company. The difference was negligible. An endurance test equivalent to 40 years' usage was performed. Other tests specially performed include 90% scram time measurement under given misalignment, vibration test, and aseismic test. In the test under seismic conditions, the 90% scram time took about 2 times as long as normal, but was permissible from a safety point. All the results of tests were satisfactory and indicated that domestic production is hopeful. (Japan)

11341 APPLICATION OF DIGITAL COMPUTER SYSTEMS IN NUCLEAR POWER PLANTS. Bevilacqua, Frank; Yuile, Edna A. (Combustion Engineering, Inc., Windsor, Conn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 196-206(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The rapid increase in the size and number of nuclear power plants has placed great emphasis on the development of instrumentation systems that will increase plant availability and prevent outages. Because modern water-cooled reactor plants operate at high power densities particular emphasis is placed on determining core performance characteristics. These performance characteristics can be calculated using an off-site computer or an on-site realtime plant computer interfaced with in-core and out-of-core sensors. The great advantage of on-line computation lies in providing the plant operator with continuous data which permits operating the plant closer to limits set by engineering, maintenance, safety, or procedural considerations. In addition, a plant computer can relieve the operator of the tedious job of logging data and can simultaneously analyze the data to determine if an operational problem exists. (auth)

11342 USE OF A GAMMA SENSITIVE DETECTOR TO MEASURE THERMAL REACTOR POWER. Czaika, J.; Kerr, W. (Univ. of Michigan, Ann Arbor). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 255-9(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A study was made of the feasibility of measuring power output of a thermal reactor with a gamma sensitive detector. Shielding was used to selectively attenuate gammas from fission products as compared to (n,γ) reactions and prompt fission gammas. Measurements indicate agreement between detector response and reactor power output, determined independently, over more than three decades. There is evidence that effects of local neutron flux perturbations, seen by neutron chambers, are ignored by the gamma detector. 5 references. (auth)

11343 SECOND-ORDER SYSTEM MODEL FOR PNEUMATIC INSTRUMENTATION LINES. Samuelson, R. D. (Aerojet General Corp., Sacramento, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 271-6(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A second-order system model is presented that approximates the transfer function of a pneumatic instrumentation line and provides a technique for simplifying the analysis of nuclear reactor control systems. The verification of this model is presented together with a discussion of its application. 4 references. (auth)

11344 GAS-COOLED NUCLEAR REACTORS. Davis, Dennis (to British Nuclear Design Construction Ltd.). British Patent 1,255,928. 1 Dec 1971. Filed 30 Nov 1967.

Reference is made to control rod systems for gas-cooled reactors. In the arrangement described an individual control system is provided for each control rod, having an actuator that varies the position of its associated control rod in relation to the average gas outlet temperature from a group of fuel channels in the neighborhood of the control rod so as to maintain the temperature at a desired level. Such an arrangement gives the

advantage of reducing the number of gag valves needing adjustment before and after refueling. The control law between the temperature and control rod actuating motor can be produced by conventional analog equipment or by digital computer. The arrangement described may include other reactor control functions, such as xenon override, overall reactor power and spatial stability, and this combination of functions results in an economic reduction and simplification of control rod systems. Each control system may include an averaging circuit for the temperatures indicated by thermocouples located adjacent to each outlet end of the associated group of fuel channels, together with a comparator for comparing the average temperature with a temperature demand signal in order to produce a temperature error signal. (UK)

Cooling Systems

Refer also to abstracts 9133, 9442, and 9923.

11345 (GEAP-10207-25) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Report No. 25, July-September 1971. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct 1971. Contract AT(04-3)-189. 59p. Dep. NTIS.

PIPES—failure in reactor cooling systems, probability analysis of
—crack initiation and growth in reactor cooling system, effects of low-cycle fatigue on, (E/T)
REACTORS, BOILING—cooling systems for, effects of corrosion on low-cycle fatigue life of piping in, (E)
REACTORS, WATER-COOLED—cooling systems for, failure mechanisms in piping for, (E/T)
STAINLESS STEEL—crack initiation and growth in Type 304, effects of low-cycle fatigue on, (E)
STEEL—crack initiation and growth in A212 and A516 carbon, effects of low-cycle fatigue on, (E) (D.L.C.)

11346 (HEDL-TME-71-147) EXAMINATION OF LMEC'S T-1D TEST FILTERS FOR PARTICULATE IMPURITIES. Greenhalgh, W. O. (Hanford Engineering Development Lab., Richland, Wash.). 30 Sep 1971. Contract AT(45-1)-2170. 19p. Dep. NTIS.

A T-1D filter from the Large Components Test Loop (LCTL) was disassembled, the particulate matter contained on the filter examined, and the vessel requalified for sodium service. A reasonable (one month maximum) turn around time for the filters was demonstrated. The applicability of particulate examination procedures to a large filter was demonstrated and areas for improvement in handling technique were defined. The particulates identified were primarily stainless steel fragments of regular geometry the source of which is postulated to be corrosion or mass transport phenomena within the system. Non-stainless steel particulates were found to contain unexpectedly high concentrations of calcium and silicon. The amount of particulate matter on the filter was found to be quite small, probably due to the inadvertent back flush of the filter with sodium during removal from the system. (auth)

11347 (IRS-T-22(1971)) THE SAFETY OF PIPE LINES AND PRESSURE VESSELS IN NUCLEAR POWER STATIONS. 6th Discussion Meeting, Bonn, Germany, November 2-3, 1970. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). 316p. (In German). (CONF-701140).

The types of failure that may occur in nuclear pipe circuits and the analysis of failures are discussed. The present status of stress mechanics and their application to reactor pressure containers are studied. Examination of structural components of pressure containers and pipe lines is presented. The design and manufacturing of large reactor pressure containers as well as to the testing of such containers are described. Panel discussions of the overall problems is included. (H.B.G.)

11348 INTERCHANNEL MIXING IN WIRE WRAPPED LIQUID METAL FAST REACTOR FUEL ASSEMBLIES. Todreas, Neil E. (Massachusetts Inst. of Tech., Cambridge); Turi, James A. Nucl. Technol.; 13: No. 1, 36-52(Jan 1972).

The available experimental data applicable to mixing rates between subchannels in wire wrapped liquid metal fast breeder reactor fuel assemblies is reviewed. A rate of mass mixing between interior subchannels of 0.03 in terms of the dimensionless ratio β (i.e., the ratio of the mixing flow rate per unit length per unit of spacing between pins to the axial mass flux) is recommended as conservative for the typical geometries of present U.S. fuel bundles. The quantitative dependence of mass mixing rates with key variables of subchannel geometry, wire lead, and pin pitch to diameter ratio is presented and discussed. (27 references) (auth)

11349 NUCLEAR REACTORS AND COOLANT THEREFOR. Baguley, Geoffrey; Shields, Daniel A. (to United Kingdom Atomic Energy Authority). U. S. Patent 3,619,365. 9 Nov 1971. Filed 17 Jul 1968.

Carbon dioxide for the cooling of a carbon dioxide-cooled, graphite-moderated nuclear reactor is mixed with hydrogen and passed over a catalyst which promotes the reaction between carbon dioxide and hydrogen to produce methane. The hydrogen is obtained by electrolysis of water in plant which may also produce argon-free oxygen for consumption in a carbon monoxide/oxygen recombination unit, converting carbon monoxide formed in the coolant to carbon dioxide. (Official Gazette)

11350 CRITICAL HEAT FLUXES OF FULL FLUX SHAPES FROM PARTIAL FLUX SHAPES. Wilson, R. H.; Geissler, G. O. (Babcock and Wilcox, Lynchburg, Va.). Nucl. Sci. Eng.; 46: No. 3, 431-6(Dec 1971).

The critical heat fluxes (CHF) of a 12-ft, axially nonuniform heat flux shape are compared with those of a 6-ft partial length of the same flux shape. For the shape used, the 6-ft partial flux shape predicts the critical heat flux performance of the full 12-ft flux shape. The location of the CHF—and hence the CHF itself—can vary considerably on axially nonuniform flux shapes without appreciably altering the corresponding channel power. (auth)

11351 IMPROVEMENTS IN OR RELATING TO LIQUID METAL CIRCUITS. Thorley, Alan William; Raine, Alan Cumberland (to United Kingdom Atomic Energy Authority). British Patent 1,254,731. 24 Nov 1971. Filed 5 Sep 1968.

Reference is made to control means for liquid metal flow into and out of dump tanks associated with liquid metal cooled reactors and associated experimental rigs. Conventional valves have a tendency to leak when used with liquid metal. In the control means described a metal bellows is provided within the tank, defining a closed volume wholly within the tank, the bellows being operated by a rod to exert control over the content of the tank. A double-acting ram is connected to the operating rod for effecting its movement, and the ram is operated by hydraulic means outside the tank. (UK)

11352 INSULATION OF NUCLEAR REACTORS. Andrew, A. Eng. Mater. Des.; 14: No. 11, 1097-8(Dec 1971).

The problems of insulation presented by the reinforced concrete pressure vessels used in nuclear reactor design are examined. In the case of the Magnox reactors a solution was found in the form of alternating layers of stainless steel foil and mesh. The construction is described and the costs evaluated. In AGR type reactors the gas temperatures are about 650°C presenting a greater insulation problem. Ceramic fibrous materials consisting mainly of alumina and silica made up in blankets of convenient thickness were tested and found suitable. The future problems presented by high temperature reactors are discussed. (UK)

11353 PRIMARY NUCLEAR PUMPS. Hoppel, R. W. (Byron Jackson Pumps Inc., Los Angeles). Nucl. Eng. Int.; 16: No. 187, 1004-5(Dec 1971).

New design concepts which evolved during the development of primary pumps for both water reactors and liquid metal reactors are reviewed. These refer to hydrostatic radial bearings, shaft seal systems, and integral heat exchangers. (UK)

11354 CIRCULATORS FOR HELIUM COOLED REACTORS. Yampolsky, J. S. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Eng. Int.; 16: No. 187, 1000-2(Dec 1971).

The series steam turbine helium circulator was developed for the helium coolant gas in the High Temperature Gas Cooled Reactor and the Gas Cooled Fast Reactor. The integration of the entire primary coolant system within the boundary of the prestressed concrete reactor vessel placed stringent requirements on the circulator. An extensive experimental proof and development program was carried out to demonstrate and predict successful operation of these machines over all possible conditions. (auth) (UK)

11355 SUBMERGED CIRCULATORS FOR AGR POWER STATIONS. Fraser, W. M. Nucl. Eng. Int.; 16: No. 187, 997-9(Dec 1971).

Increasing coolant gas pressures in AGR circuits brought about a re-appraisal of main gas circulation designs, resulting in the adoption of compact centrifugal circulators with submerged motor drives for the Hinkley Point B, Hunterston B, Hartlepool and Heysham AGR power stations. These are horizontal shaft constant speed machines for Hinkley and Hunterston but vertical units for the pod boiler type stations at Hartlepool and Heysham. Design details are presented and testing and maintenance are briefly described. (auth) (UK)

11356 PRIMARY REACTOR CIRCULATORS: TECHNICAL SURVEY NO. 6. Nucl. Eng. Int.; 16: No. 187, 993-1012(Dec 1971).

A survey is presented of the development, manufacture, and testing of primary circulators for nuclear reactors. The technologies of systems using water, CO_2, He, and liquid Na are separately discussed. Descriptions are given of the sodium pumps for the Phenix reactor, bearings and seals for primary pumps, testing the prototype circulation pump for the SNR test breeder, and the Finnatom loop test rig for full scale testing of primary circulators. A data sheet is provided which lists the suppliers of primary circulators and the range of equipment manufactured. Separate abstracts are presented for each of the 7 articles. (UK)

Fuels

Refer also to abstract 9428.

11357 (EUR-4690) POSTIRRADIATION EXAMINATIONS OF A FUEL BUNDLE OF THE VAK-REACTOR AND COMPARISON WITH CALCULATIONS. Koch, L.; Hochstein, P.; Pohl, P.; Wolff, U. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). 21 Jun 1971. 52p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 5,10.

A fuel assembly of the VAK-reactor with an averaged burnup of 14 GWD/MTU was subjected to intensive postirradiation examinations. The results were compared with those obtained by calculations. Gamma scans of two rods were taken and afterwards the burnup of Nd-148, the content of heavy isotopes, and the fission gas isotope ratios were determined by destructive methods. Between some isotope ratios and burnup parameters linear correlations were observed. Burnup and distribution of heavy isotopes were calculated from the irradiation history by means of computer codes, which are described. The agreement between measurement and calculation is sufficient. 11 references. (auth)

11358 POST-SHUTDOWN SURGES IN COVER GAS ACTIVITY IN EXPERIMENTAL BREEDER REACTOR II (EBR-II). Brunson, G. S.; Fryer, R. M.; Strain, R. V. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Technol.; 13: No. 1, 6-19 (Jan 1972).

The sodium-bonded uranium-metal fuel elements used as driver fuel in EBR-II exhibit a characteristic fission-product release when a leak occurs in the lower part of the element. Shutting off the primary pumps at reactor shutdown reduces the effective ambient pressure, and bond sodium bearing fission-product iodine is extruded into the primary coolant by the gas in the fuel-element plenum. The decay of the extruded iodine produces a surge in the xenon activity which reaches a maximum 11 or more hours after the reactor is shut down. An experimental fuel element with an intentional leak was irradiated in the reactor during several different runs so that this effect could be observed under reasonably controlled conditions. A simple model fairly well relates the size of surge to reactor power, location of the leaking element in the core, and timing of pump operation. (11 references) (auth)

11359 FUEL SUBASSEMBLY FOR A NUCLEAR REACTOR. Chubb, Walston; Keller, Donald L.; Wullaert, Richard A.; Storhok, Victor W. (to United States Atomic Energy Commission). U. S. Patent 3,619,366. 9 Nov 1971. Filed 6 May 1969.

A fuel subassembly for a nuclear reactor incorporating a body of uranium dioxide or mixed uranium–plutonium dioxide fuel within an elongated casing is described. A gas plenum is located at the top and bottom of the subassembly and a metal tube or rod serving as a heat sink extends along the axis of the subassembly. (Official Gazette)

11360 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Rose, Kenneth Miles; Chamberlain, Alan (to United Kingdom Atomic Energy Authority). British Patent 1,253,515. 17 Nov 1971. Filed 8 Feb 1968.

Reference is made to support arrangements for fuel elements in reactors of the Magnox type. One form of support arrangement comprises an axially projecting conical support member at one end of each fuel element and a second support member having a conical recess at the other end of the fuel element, this arrangement being suitable for the stacking of fuel elements one on another within vertical fuel channels. In such an arrangement difficulty may arise due to the support members sticking together. With a view to overcoming this difficulty BP 1,046,460 Oct 21, 1963, provided for the conical recess to have a carbon mating surface and for the other support member to have a stainless steel mating surface. The present arrangement provides for infrared anti-sticking materials; the mating surface of one of the support members is of sintered Al_2O_3 having a thin carbon coating, and that of the other is of stainless steel. The conical support member may have a stainless steel mating surface in the form of a shim secured to its body, while the other support member may have an insert of sintered Al_2O_3, having a conical recess the surface of which has a thin coating of carbon. (UK)

Auxiliary and Emergency Systems

11361 ACOUSTIC BOILING DETECTION IN REACTOR VESSELS. Anderson, T. T.; Grate, T. A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 260-5(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Reactor coolant which boils in a fast reactor or high-flux research reactor, endangering reactor safety, can be detected acoustically. As a contribution to design of acoustic boiling detectors, the tank wall of a reactor is shown theoretically to affect standing waves in that tank. Experimental resonance frequencies of a 3-ft-diameter tank demonstrate that for low-pressure reactor tanks, the pressure at standing-wave frequencies is nearly zero at the tank wall, in contrast to the results for a perfectly rigid wall. 10 references. (auth)

11362 COMPARATIVE SPEED OF ALARM PROTECTION SYSTEMS FOR A NUCLEAR REACTOR. Kazachkov, V. I.; Alpeev, A. S. At. Energ. (USSR); 31: No. 6, 627-8(Dec 1971). (In Russian).

The rapid response of emergency protection systems for nuclear reactors is evaluated by a family of curves which relate the safeguard factor to the period of the reactor and the time constant of the differentiating circuit. Using the equations developed, it is possible to estimate the relative speed of protective channels according to the power or the period under given conditions. (K.S.W.)

Operation and Economics

11363 (CEA-CONF-1844) ECONOMIC STUDY ON PLUTONIUM RECYCLING IN ORDINARY WATER REACTORS. Charpentier, J. P.; Deledicq, A.; Thiriet, L. [1971]. 18p. (In French). (CONF-710616-4). Dep. NTIS (U. S. Sales Only).

From Panel on plutonium recycling in thermal power reactors, Vienna, Austria (21 Jun 1971).

An economic model for the Pu recycling in ordinary water reactors is derived. The model makes possible the optimum management of thermal reactors as a function of the data for breeder operation and permits an examination of the general conditions of the recycling of Pu in thermal reactors. (J.S.R.)

11364 (CEA-CONF-1845) GENERAL REPORT ON RECYCLING OF PLUTONIUM IN FRANCE. [nd]. 4p. (In French). (CONF-710616-3). Dep. NTIS (U. S. Sales Only).

From Panel on plutonium recycling in thermal power reactors; Vienna, Austria (21 Jun 1971).

France has not participated in the studies made on the recycling of Pu in water-cooled reactors. The technical problems to be solved for the productive participation of France include the selection of the method of recycling, fabrication problems, and the construction of a fabrication workshop. (J.S.R.)

11365 (KR-145) CORE FOLLOW STUDY OF THE DODEWAARD REACTOR WITH THE THREE-DIMENSIONAL BWR SIMULATOR PRESTO. Nitteberg, J.; Haugen, J.; Rasmussen, J.; Sauar, T. O. (Institutt for Atomenergi, Kjeller (Norway)). Oct 1971. 51p. Dep. NTIS (U. S. Sales Only).

The three-dimensional, BWR simulator PRESTO was used in a core follow study of the first fuel cycle of the Dodewaard reactor, covering the burnup range from 0 to 11,000 MWD/TU. The physical model of the PRESTO simulator, as well as the applied methods of data preparation, are presented. Emphasis is placed on the ability of the simulator to predict spatial power distributions. A special program routine is constructed to handle both measured and calculated power distributions and produce plots for the purpose of comparison. The results show very satisfactory agreement between calculated and measured power distributions. Effects of control rods and curtains, as well as the void distribution, are well described by the method. The study demonstrates overall feasibility of the PRESTO simulator and the data preparation procedure applied. 21 references. (auth)

11366 ECONOMIC ANALYSIS OF THE NUCLEAR FUEL CYCLE. Girvin, Larry M. (Virginia Electric Power Co., Richmond); Witzig, Warren F. Nucl. Technol.; 13: No. 1, 53-64(Jan 1972).

A simplified nuclear fuel depletion model along with a unique economic model was developed to perform nuclear fuel cost analyses. The depletion model is structured with a relatively inexpensive zero dimensional depletion code (LEOPARD). In developing the economic model, particular recognition was given to the utility accounting procedures, tax structure, and debt structure. The particular economic analysis demonstrated is limited to a small phase of the nuclear fuel cycle. Additional work is being conducted to expand the basic concept to the entire fuel cycle. The economic model shows great utility in analyzing the nuclear fuel leasing vs owning decision. (23 references) (auth)

11367 ABOUT DETERMINATION OF MAXIMUM PERMISSIBLE CAPACITY OF NUCLEAR POWER REACTORS TAKING INTO ACCOUNT CORE THERMAL RELIABILITY. Batov, V. V.; Konstantinov, L. V.; Koryakin, Yu. I.; (and others). At. Energ. (USSR); 31: No. 6, 563-6(Dec 1971). (In Russian).

A method is proposed to determine the maximum permissible capacity of nuclear power reactors that takes into account the core thermal reliability. To calculate the reactor optimum power, a method of normalized expenditures was used. Assuming the reactor channel burnout safety margins to be a stationary random process, an average number of boiling channels falling under heat transfer crisis conditions for a certain period of time is determined on the basis of power peak theory. With reactor power increase, the power output per time unit increases too, this resulting in the specific capital costs for a nuclear power station and the constant prime cost decrease, but the expenditures caused by fuel channel failures and the reactor shutdown for discharging defected channels and charging new ones increase. Thus a nuclear power station can operate under some optimum conditions. To calculate the optimum operating conditions, the transcendental equation is derived. 4 references. (auth)

11368 BREEDING RATIO WITH CORRELATION TO DOUBLING TIME AND FUEL CYCLE REACTIVITY VARIATION. Adkins, C. R. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Technol.; 13: No. 2, 114-30(Feb 1972).

The standard definition of the breeding ratio is subject to some suspicion, since in many cases of practical interest it gives an incorrect measure of the fissile fuel doubling time and erroneous trends of the fuel cycle reactivity variation. The reasons for this behavior are given, along with the methods for removing the difficulties. In addition to the standard definition, the method of η-weighting due to Ott and the method of reactivity weighting due to Baker and Ross (British definition) are examined. It is shown that the η-weighting procedure is not much better than the standard definition, whereas the British definition can be used to give very good results for the doubling time and fuel cycle reactivity variation. The standard for comparison is a detailed explicit fuel cycle analysis of both the startup cycle and equilibrium cycle of an oxide fast reactor. With the methods given it is shown that the important quantities needed from a single fuel cycle analysis can be obtained just from a statics calculation, for the known composition at the beginning of the fuel cycle of interest (e.g., first fuel cycle). This result has significant importance for conceptual design studies and for optimization studies where many reactor calculations must be performed, precluding the use of an explicit fuel cycle depletion analysis. However, it is also shown that the equilibrium fuel cycle performance cannot be adequately predicted solely from start of life statics analysis. An approximate procedure is formulated to predict the equilibrium reactor composition, from which the equilibrium breeding gain, doubling time, and reactivity variation may be determined. 9 references. (auth)

Safety and Siting

Refer also to abstract 9537.

11369 (COO-2152-1) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report, July 1-September 30, 1971. Weisman, Joel (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). Contract AT(11-1)-2152. 6p. Dep. NTIS.

Pressure drop and heat transfer phenomena of importance during a loss of coolant accident are investigated. The study is divided into three major experiments: (a) Transient Pressure Drop Investigation; (b) Two-Phase Pressure Drop and Flow Pattern Study; (c) Transition Boiling and Reflooding Heat Transfer Tests. (auth)

11370 (RT/PROT-(71)30) DYNAMIC ANALYSIS OF A CYLINDRICAL-HEMISPHERICAL COMBINATION. Sano, T.; Fedele, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 16 Jul 1971. 54p. (In Italian). Dep. NTIS (U. S. Sales Only).

The dynamic behavior of a hemispherical-cylindrical containment building was examined. Natural frequencies and mode shapes as well as the response to an earthquake ground motion were calculated 18 references. (auth)

11371 (RT/PROT-(71)31) NCOMEUR: IBM-7094 PROGRAM FOR CALCULATION OF REACTIVITY TRANSIENTS AND POWER IN A NUCLEAR REACTOR. Palma, F.; Sardone, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28 Jul 1971. 151p. (In Italian). Dep. NTIS (U. S. Sales Only).

A computer code for the evaluation of the consequences of power transients in water reactors with MTR fuel elements is described. The code is able to analyze reactor core transients dealing with cross-fuel melting. A study to check analytical results with experimental transients of the SPERT program and to work through a brief analysis concerning the sensitivity of the code to parameters was made. 13 references. (auth)

11372 UNDERGROUND SITING FOR NUCLEAR POWER PLANTS. Olds, F. C. Power Eng.; 75: No. 10, 34-9(Oct 1971).

Several studies of underground nuclear plant siting are described, and the economics and safety improvements of underground siting are discussed. The underground siting of the Halden, Agesta, Chooz, and Lucens reactors is briefly described. (H.D.R.)

11373 ENVIRONMENTAL POLLUTION AND ITS CONTROL. Baxter, J. P. (Australian Atomic Energy Commission, Coogee). At. Energy Aust.; 14: No. 2, 2-7(Apr 1971). (CONF-710220-1).

From Symposium on the advance of process automation in industry; Sydney, Australia (16 Feb 1971).

A comparison is made between emanation of pollution from fossil-fuelled power stations and nuclear power stations. Safety precautions taken to limit escape of fission products to levels below the permissible levels of discharge from nuclear power reactors are outlined, and these levels are compared with natural background exposures. (Australia)

11374 NUCLEAR SAFETY. VOLUME 13, NUMBER 1. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P. One of Four Technical Progress Reviews Published for the Technical Information Center, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Jan-Feb 1972). 99p. GPO $0.60.

Included are 13 articles on safety related activities associated with nuclear facilities. A separate abstract or title listing was prepared for 10 articles. (H.D.R.)

For abstracts of individual papers see: 11375-11384.

11375 ROLE OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS IN THE REACTOR LICENSING PROCESS. Bush, Spencer H. (Battelle-Northwest, Richland, Wash.). Nucl. Safety; 13: No. 1, 1-13(Jan-Feb 1972).

The role of the Advisory Committee on Reactor Safeguards (ACRS) in the reactor licensing process is reviewed in the context of its original charter established by Congress. Specifically, membership and operational procedures are reviewed with respect to specific projects. An important activity of the ACRS is review of generic safety items and codes, standards, and criteria. Recommendations and comments are made concerning areas where continuing improvements are possible in the regulatory work load, evaluation of design concepts, and operation of the ACRS. 16 references. (auth)

11376 SOME EFFECTS OF PUBLIC INTERVENTION ON THE REACTOR LICENSING PROCESS. Bright, G. O. (National Reactor Testing Station, Idaho Falls, Idaho). Nucl. Safety; 13: No. 1, 13-21(Jan-Feb 1972).

The environmental protection movement has greatly affected the civilian power-reactor licensing process. Intervention in public licensing hearings and court action have both been widely employed, with a net result, in many cases, of significantly increasing the time required to obtain both construction and operating licenses. It is concluded that a strong effort must be made by industry if protracted delays are to be avoided. (8 references) (auth)

11377 DEVELOPMENT OF REACTOR SITING CRITERIA BASED UPON RISK PROBABILITY. Meleis, Mahmoud; Erdmann, Robert C. (Univ. of California, Los Angeles). Nucl. Safety; 13: No. 1, 22-8(Jan-Feb 1972).

Examination of the originally proposed Farmer limit-line criterion for nuclear plants led to a total individual mortality risk that is fairly high with respect to other recorded risks. For example, in the case of an equal wind-direction probability of $1/12$ (any 30° vector over a 360° circle), the total risk from an accidental release at the plant was only 3.4×10^{-6} but was still 34 times that caused by lightning. A new location for the limit line was therefore deduced that would satisfy both Farmer's probabilistic

safety-analysis philosophy and at the same time limit the added risk to the individuals living at the exclusion radius to a very low value. Finally, the probabilitistic safety analyses of three existing nuclear plants are compared with the original and modified limit lines. Hence one can observe a correspondence between calculated plant release data and the limit-line concept. An integrated safety analysis based on the limit-line concept could provide the nuclear industry with an adequate reactor siting technique. 11 references. (auth)

11378 CONTAMINATION CONTROL OF SODIUM RELEASES FROM LIQUID-METAL-COOLED FAST BREEDER REACTORS. First, M. W. (Harvard Univ., Cambridge, Mass.). Nucl. Safety; 13: No. 1, 37-46(Jan-Feb 1972).

Although liquid-metal-cooled fast breeder reactors are designed to avoid sodium releases, sound public-health practice demands that the nature and potential consequences of every conceivable type of release be evaluated. A typical reactor handling large volumes of hot sodium is analyzed carefully to determine where accidental leaks and spills may occur. Standby control methods are recommended to prevent spread of airborne sodium and its reaction products, to reduce reactor shutdown time, and to minimize cleanup costs. Critical factors affecting the design of engineered controls for the containment of accidental sodium releases were temperature of the metal, oxygen concentration and size of the space into which the spill or leak occurs, rate of sodium escape, and the amount of sodium likely to be released before remedial measures can be taken to stop it. 15 references. (auth)

11379 FAILURES OF THREADED FITTINGS AND FASTENERS AT NUCLEAR FACILITIES. Scott, R. L.; Harley, P. H. Nucl. Safety; 13: No. 1, 47-53(Jan-Feb 1972).

Thirty-three incidents are tabulated concerning problems encountered with bolts, screws, nuts, and threaded fittings, all of which should be of interest to both designers and operators. These incidents have required approximately 70 months of additional reactor downtime. At one facility an estimated expenditure of $10,000 was caused by the failure of a 1-in. threaded strainer plug. The three major types of failures—corrosion, fatigue, and galling—are discussed. 56 references. (auth)

11380 ESTIMATING FISSION-PRODUCT RADIATION AND THERMAL-POWER SOURCE STRENGTH. Clack, R. W.; Eckhoff, N. Dean (Kansas State Univ., Manhattan). Nucl. Safety; 13: No. 1, 54-5(Jan-Feb 1972).

Procedures are presented for approximating the fission-product source strength from typical power reactors. (H.D.R.)

11381 SAFETY-RELATED OCCURRENCES REPORTED IN AUGUST–SEPTEMBER 1971. Casto, W. R. (Comp.). Nucl. Safety; 13: No. 1, 55-9(Jan-Feb 1972).

11382 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Sheldon, Myrtleen (Comp). Nucl. Safety; 13: No. 1, 60-9(Jan-Feb 1972).

11383 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. (Comp.). Nucl. Safety; 13: No. 1, 75-94(Jan-Feb 1972).

11384 SUMMARY OF LEGISLATIVE AND REGULATORY ACTIVITIES AFFECTING THE ENVIRONMENTAL QUALITY OF NUCLEAR FACILITIES. Bryan, R. H.; Nichols, B. L. (Comps.). Nucl. Safety; 13: No. 1, 95-8(Jan-Feb 1972).

11385 CRITERIA OF SAFETY IN THE EVALUATION OF SITES FOR NUCLEAR REACTORS (METHOD FOLLOWED IN THE UNITED STATES). Alonso Santos, Agustin (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 15: No. 72, 276-82 (Jul-Aug 1971). (In Spanish).

The basic criterion of safety established in the United States for the siting without risks of nuclear reactors is reported. The systematics used in the practical application of this principle is described. The formulas cited are based on deductions made earlier. Two extreme cases are reported; the range of applications of the safety principle is indicated. (tr-auth)

Power Conversion Systems

11386 HEAT UTILISATION PLANT. Shaw, James William Westgarth; Chapman, Dennis Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,253,246. 10 Nov 1971. Filed 29 Mar 1968.

Reference is made to heat utilization plants associated with gas cooled reactors. In such plants it is usual to employ water tubes in helical or serpentine arrays, for volumetric flow reasons, despite the cost of fabricating these tubes into a heat exchanger. The system described comprises a vapor generating device that converts liquid feed into superheated vapor and incorporates means for extracting heated liquid at a point intermediate between the liquid inlet and superheated vapor outlet. A multistage vapor utilization means and a vapor reheating heat exchanger are provided, the latter being connected to extract heat from the heated liquid for reheating the vapor as it passes between stages of the vapor utilization means and to return the liquid into the liquid feed entering the vapor generating device. The means for extracting heated liquid can be a separating drum disposed between evaporating and superheating stages of the heat exchanger. The main advantage of this system is the smaller surface area needed for a liquid/gas heat exchange as compared with a vapor/gas exchange; also a parallel flow may be adopted instead of the costly helical tube arrangement. (UK)

Research and Test Reactors

Refer also to abstracts 8878, 9071, 9112, 9113, 9179, 9212, 9214, 9321, 9847, 10912, 11329, 11330, 11346, and 11381.

11387 (ANCR-1027) PERFORMANCE EVALUATION OF CORE II AND III ADVANCED TEST REACTOR FUEL ELEMENTS. Graber, M. J.; Hayner, G. O.; Hobbins, R. R.; Gibson, G. W. (Aerojet Nuclear Co., Idaho Falls, Idaho). Oct 1971. Contract AT(10-1)-1375. 63p. Dep. NTIS.

Post-irradiation examinations were performed on five fuel assemblies that had been in service in the Advanced Test Reactor (ATR) during startup Cores II and III. Both UAl_x and U_3O_8 were used as the fissile dispersants in these Al clad, plate type, dispersion fuel elements. The examination showed that the elements had performed well. The ATR fuel design basis was for a 17 day, 4250 MWd cycle. Three of the fuel elements examined had been in service for over twice the design exposure, or 1.5×10^{21} fiss/cc of plate core. A few of the plates were found to have cladding ruptures attributed to thin cladding at core ends. (12 references) (auth)

11388 (AWRE-O-62/71) TEMPERATURE MEASUREMENT ON THE VIPER PULSED REACTOR. Mullender, M. L. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1971. 42p. Dep. NTIS (U. S. Sales Only). UK 45p.

The fuel temperature in the VIPER pulsed reactor rises 400°C in less than 1 ms. Measurement of such rapid temperature changes poses problems in the design of suitable thermocouples. Intrinsic junctions in which the heated fissile material forms part of the junction were designed and their response as a function of wire diameter compared with a simplified theoretical model. A robust version is used as a sensor for a fast acting reactor shutdown channel. The use of temperature paints and indicators in the pulsed reactor was also assessed. (11 references) (auth) (UK)

11389 (DOCKET-50231-105) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Reflector Control Circuit Relay Malfunction. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 17 Dec 1971. 3p. Dep. NTIS.

11390 (DOCKET-50231-106) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Modification of the Reactivity Predicting Equation for SEFOR Core II. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 17 Dec 1971. 5p. Dep. NTIS.

11391 (DOCKET-50231-107) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Tenth Quarterly Plant Operation Report, August 1–October 31, 1971. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 28 Dec 1971. 29p. Dep. NTIS.

11392 (HEDL-TME-71-121) FUEL MOTION RESTRICTOR SCREENING CAPSULE IRRADIATIONS. Pember, L. A. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. Contract AT(45-1)-2170. 71p. Dep. NTIS.

A series of capsules were irradiated in the MTR VH-4 facility to test the compatibility of various restrictor materials with molten mixed oxide fuel and the effectiveness of various restrictor designs in limiting molten fuel relocation. Restrictors of metallic and ceramic materials and of grooved and annular designs in both fixed-to-the cladding and floating concepts were tested in 30-minute irradiations. Test results indicate the metallic restrictors were compatible with the fuel and effectively prevented fuel relocation. The floating restrictor concept was selected for subsequent use because of ease of assembly in a fuel pin. (auth)

11393 (HEDL-TME-71-153) FTR SET 300, MULTIGROUP CROSS SECTIONS FOR FTR DESIGN. Schenter, R. E.; Kidman,

R. B.; Nelson, J. V. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1971. Contract AT(45-1)-2170. 160p. (ENDF-164). Dep. NTIS.

Presented is a 30-group cross section library, called FTR Set 300, which will be used in the Fast Test Reactor (FTR) design calculations. The library consists of tables of infinitely dilute cross sections and resonance self-shielding factors for 25 materials (isotopes or elements). These group constants were generated using the ETOX code with ENDF/B-II data as input. The resulting infinitely dilute cross sections were modified for several isotopes to give calculational agreements with measured fast reactor integral experiments. (12 references) (auth)

11394 (ORNL-TM-3661) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JULY-SEPTEMBER 1971. Hurt III, S. S.; Tabor, W. H. (Oak Ridge National Lab., Tenn.). 2 Dec 1971. Contract W-7405-eng-26. 46p. Dep. NTIS.

The ORR was operated at an average power level of 29.8 MW during 93.3% of the time in July, August, and September of 1971. The process and clean-up systems operated satisfactorily, and fuel utilization was improved as evidenced by the high burnup (~54%) of the 16 fuel elements which were depleted during the quarter. A new shim-rod-rotation schedule which will improve shim-rod utilization was effected. The reactor was shut down only approximately 149 hours, 11.4 hours of which were unscheduled. Most of the unscheduled downtime (99.3%) was the result of a plant-wide power outage caused by faulty insulators in the electrical distribution system. Three of the scheduled reactor shutdowns followed low-power tests. Work continued on the normal off-gas (NOG) filter system where water collection had been found to be a problem. Special tests conducted during the quarter included flux measurements in a simulated flux-trap experiment and the calibration of all six shim rods. (auth)

11395 EXTENSION OF THE DUAL SPECTRUM FUEL ASSAY CONCEPT. Kelber, C. N. (Argonne National Lab., Ill.). Nucl. Technol.; 13: No. 1, 95-102(Jan 1972).

The concept of a dual spectrum facility for the assay of reactor fuel is extended to include the assay of thermal reactor fuel as well as LMFBR fuel, and the problems of neutron filter choice and moderator choice are examined. An estimate is made of the resistance of the concept to errors introduced by tampering with the Pu distribution. The dual spectrum concept involves oscillating fuel against a standard in a hard spectrum in a dilute fast critical assembly, then softening the spectrum by introducing a moderator into the voids in the assembly, and oscillating the fuel inside various neutron absorbers or filters. The choice of moderator and of neutron filter is a set of design variables, and the objective was to determine that set of design variables which yields the lowest estimated bound on the error inherent in the fuel assay, and to extend these considerations to the assay of thermal reactor fuel. It is concluded that the filters Hg, B, and Cd, together with water or graphite moderator, offer an optimal design set. The errors in the assay of fuel are, roughly, inversely proportional to the mass content of the fuel; the resistance to tampering is found to be high. (auth)

11396 METHOD WITH IMPROVED ACCURACY FOR THE DETERMINATION OF BURN-UP IN NUCLEAR REACTOR BUNDLES THROUGH GAMMA-RAY SPECTROMETRY. Schaechter, L.; Popa, P.; Hacman, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 7, 757-63(1971).

A method for the determination of a correction factor for the axial and radial distribution of burnup in irradiated fuel elements is described. The method is based on measurements made on a fuel bundle in the thermal column of the Bucharest VVR-S. The effect of a non-uniform distribution of fuel elements in a cassette was studied in order to determine a geometric intrinsic factor. The cassette, or mini-bundle, reproduces on a reduced length the geometry of the irradiated fuel bundle. The ^{140}La activity was measured to obtain the geometric correction factor for burnup determinations. (H.D.R.)

11397 CRITICAL ASSEMBLIES AND REACTOR RESEARCH. Schmid, Loren C. New York; John Wiley and Sons, Inc. (1971). 396p. $21.95.

Theoretical and experimental techniques for the study of thermal reactor physics are presented. Discussions cover general features of thermal research reactors, reactor characteristics, reactor operation, and reactor and neutron physics research. Experimental measurement techniques are described, and controllability and dynamics of critical reactors are discussed. (H.D.R.)

11398 APPLICATION OF AN ON-LINE DIGITAL COMPUTER TO THE CONTROL SYSTEM OF THE HIGH FLUX ISOTOPE REACTOR (HFIR). Bullock, J. B.; Danforth, H. P. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 222-6(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

A process control computer was combined with the analog control system of the HFIR to perform the function of limiting the shim-rod reactivity additions as well as direct shim-rod symmetry control. Automatic shim control is supervised by a computer program which uses the measured reactor power level to continuously compute the core reactivity requirements during the 23-day fuel cycle. The high power density (4 MW/liter) in the HFIR requires that flux tilting be controlled to minimize the possibility of hot-spot formation. This is accomplished by limiting the difference in shim-rod positions for reactor operation above 10 MW. The rod symmetry is controlled by a computer program that actuates rod control relays in the analog system in response to the asymmetry determined from shim-rod position sensors. The rod control algorithm was tested on-line at 10 MW, and routine operation of the on-line programs is planned after the overall reliability of the system has been measured. 4 references. (auth)

11399 SAFETY CIRCUITS FOR CRITICAL ASSEMBLIES. Bilharz, O. W. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 249-54(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

Safety circuit designs for critical assemblies are somewhat different in concept from those applied to power reactors due to differences in operation and to different importance factors attached to various possible failure modes. The development of such circuit designs is described to illustrate past and current practices which have been found practical, efficient, and reliable. A number of problem areas and their solutions are given in order that similar problems might be avoided in future design. Directions for future development effort are indicated. 6 references. (auth)

11400 BURST CARTRIDGE DETECTION IN BR-5. Efimov, I. A.; Mamaev, L. I.; Filonov, V. S. At. Energ. (USSR); 31: No. 6, 567-71(Dec 1971). (In Russian).

The long-term investigation of various methods of burst cartridge detection at the sodium cooled BR-5 reactor resulted in the selection of the delayed neutrons method accompanied by the periodic measurements of fission products activity in samples of the coolant and gas. This equipment permits the detection of the manner and the moment of a burst in fuel elements. (auth)

11401 ENVIRONMENTAL RADIOACTIVE PURITY NEAR IRT-2000. Mishev, I. T.; Radicheva, M. A. At. Energ. (USSR); 31: No. 6, 577-80(Dec 1971). (In Russian).

The general data of the environmental radiation control near nuclear reactor IRT-2000 in Sofia from September 1961 until the end of 1968 are presented. The conclusion is that reactor environmental contaminations do not exist. A constant decrease of β-activity in water dry residue of the reactor fountain pool was also found. The β-activity in water dry residue of the snow from the Vitosha Mountain was measured several times and it was established that this activity has decreased as the aerosol β-activity measured near the reactor. 5 references. (auth)

11402 DER EINSATZ VON FORSCHUNGSREAKTOREN VOM SCHWIMMBAD-TYP FUER MATERIAL-BESTRAHLUNGS-EXPERIMENTE. (Introduction of Research Reactors of the Swimming Pool Type for Material Radiation Testing). Fischer, E.; Melkonian, G. A. (eds.). KEST No. 17. Muenchen; Verlag Karl Thiemig KG (1969). 75p.

Three reports on the use of swimming pool reactors for material testing are presented. The operation of a swimming pool reactor for material irradiation, the development of irradiation capsules, and problems and methods for the testing of reactor materials at the Geesthacht research reactor are considered. (J.S.R.)

11403 DETERMINATIONS OF EXPOSURE RATES IN THE COURSE OF MODIFICATION OF THE REACTOR DIORIT. Jeschki, W. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Kerntech. Atomprax.; 13: No. 10, 450-3(Oct 1971). (In German and English).

Using the reactor DIORIT as an example, the methods are discussed for determining with a satisfactory accuracy the activities and exposure rates, information on which is required for planning modifications or repairs involving the reactor core. Methods are suggested for avoiding the difficulties which were encountered in determining exposure rates on the occasion of the modification of the reactor DIORIT. (auth)

11404 ADIABATIC CALORIMETRY OF REACTOR RADIATION. Charanda, M. R. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 103-6(1971). (In Belorussian).

Calorimetric measurements of dose intensity were conducted with an adiabatic calorimeter in the vertical hole of the reactor IRT-2000. A series of materials was used: graphite, oxygen, aluminum, sapphire, and glass. The contribution of gamma radiation was found as the difference between the experimentally measured total dose and the calculated dose due to neutrons. The accuracy of the measurements was estimated to be 3%. (tr-auth)

11405 INSTRUMENT-EQUIPPED FUEL CREEP CAPSULE. Haefner, H. E.; Will, H. (Institut fuer Reaktorentwicklung, Karlsruhe, Ger.). Kerntech. Atomprax.; 13: No. 10, 454-7(Oct 1971). (In German and English).

An irradiation rig was developed for the Karlsruhe research reactor FR2 which allows continuous measurement of the variations of length of fuel specimens under irradiation and a pneumatically maintained compression load, by means of radiation-resistant inductive displacement pickups (differential transformers). The arrangement allows the variation, from one specimen to another, of the parameters power density, sample loading and sample temperature. The irradiation rig and the measurement system are described, and initial operating experience is reported. (auth)

11406 EVALUATION OF THE ENVIRONMENTAL SIGNIFICANCE OF THE PROJECTED ^{41}Ar RELEASE FROM THE LOWELL TECHNOLOGICAL INSTITUTE REACTOR. Skrable, Kenneth W.; Chabot, George; Killelea, Joseph; Wedlick, Harold (Lowell Tech. Inst., Mass.). Health Phys.; 22: No. 1, 49-56 (Jan 1972).

Because of the nearness of buildings to the 100 ft reactor stack of the Lowell Technological Institute research reactor, standard diffusion equations were not directly applicable to the calculation of ground concentrations from the projected ^{41}Ar release of 400 $\mu Ci\ sec^{-1}$. Because of this and the proximity of the City of Lowell, there was some reluctance to use any atmospheric dilution in the evaluation of exposure concentrations. Since the stack concentration of $5.7 \times 10^{-5}\ \mu Ci\ cm^{-3}$ is considerably above the MPC of $4 \times 10^{-8}\ \mu Ci\ cm^{-3}$, other physical and mathematical models had to be used in the evaluation of the environmental significance of the projected ^{41}Ar release. These models and an evaluation of the basis for the ^{41}Ar MPC indicated the general inapplicability of infinite cloud submersion dose MPC values and showed that these values may be unrealistic and unduly restrictive especially in the case of exposure to finite volumes of short lived, inert, beta–gamma emitting, radioactive gases. (auth) (UK)

Rocket and Space Reactors

Refer also to abstract 9441.

11407 COMPUTER DATA PROCESSING TO COMPUTE NERVA TRANSFER FUNCTIONS. Benenson, H. (Aerojet-General Corp., Sacramento, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 207-9(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

For complex systems and for systems where only a limited number of tests can be conducted, computers are needed to simulate the system for performing design and malfunction studies. These tests are conducted to, first, verify the validity of the simulation and, second, to upgrade the analytical program when test data become available. In the NERVA system, one of the methods for evaluating the analytical description and computer simulation is through the application of transfer functions. The computer data-processing methods that have been developed to permit total data analysis completion within a 72-hr period are described. To achieve this goal, it was necessary to establish efficient and flexible programming methods and to ensure that the data are valid when the tests are conducted. Because interpretation is essential, a well planned systematic approach to verification and simulation was introduced early in the program to study and interpret anomalies that could occur in the data. (auth)

11408 INSTRUMENTATION FOR NUCLEAR ROCKET ENGINES. Gilles, W. P. (Aerojet-General Corp., Sacramento, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 1, 266-70(Feb 1969).

From fifteenth nuclear science symposium; Montreal, Canada (23 Oct 1968).

The NERVA program presents many difficult instrumentation design problems. Gamma fluxes reach 10^9 rads(C)/hr and neutron fluences approach $10^{18}\ n/cm^2$ ($E > 1.0$ MeV), while temperature ranges from 40 to 4500°R. A summary of these problems and their solutions is discussed. (auth)

Process Heat and Desalination Reactors

11409 (EUR–4684) HTRCP: HIGH TEMPERATURE REACTOR FOR CHEMICAL PURPOSES (AN APPLICATION FOR THE STEEL-MAKING INDUSTRY). Angelini, A. (ed.) (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug 1971. 76p. Dep. NTIS (U. S. Sales Only). EUR FF 11.-.

The reference design of a High Temperature Reactor (HTGR) to be combined with a chemical plant (steam reforming) for metallurgical purposes is described. The principal features of a nuclear plant, whose output corresponds to the power demand necessary to achieve a yearly production of $3.5.10^6$ tons of iron sponge, are presented. Cost estimates indicate an economical saving of 30% if comparison is made with conventional thermal sources, which corresponds to a net gain of 10% on the final product (steel). This economical evaluation does not account for the research expenses necessary to realize the reactor, whose temperatures (mean gas outlet temperature: 950°C) exceed the operating temperatures reached up to now by nuclear power stations. 12 references. (auth)

Reactor Theory

11410 (LA–4836) CORRESPONDENCE BETWEEN THE TIME- AND CRITICALITY-EIGENVALUE PROBLEMS FOR A BARE-SLAB REACTOR. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 6p. Dep. NTIS.

The time- and criticality-eigenvalue problems are discussed, and a correspondence between time and criticality eigenvalues (and eigenfunctions) is established. The "critical flux" and lowest time eigenfunction are shown to be positive, and the associated eigenvalues are shown to be simple. 13 references. (auth)

11411 (RISO–M–1437) RESOREX: PROCEDURE FOR CALCULATING RESONANCE GROUP CROSS-SECTIONS. Neltrup, H. (Danish Atomic Energy Commission, Risoe, Research Establishment). Oct 1971. 25p. Dep. NTIS (U. S. Sales Only).

The procedure RESOREX which calculates Resonance Region Group X-sections is described. The procedure uses resonance integrals tabulated as a function of effective NR-scattering cross-section and physical temperature. These resonance integrals are generated on punched cards by the RESAB program system. The effective NR-scattering cross-section is derived from an equivalence principle corresponding to cylinder, square, and hexagonal geometries. Correction for a cladding region containing heavy (WR) nuclides is used. (auth) (Denmark)

11412 APPLICATION OF NONLINEAR PROGRAMMING TO THE OPTIMAL CONTROL OF POINT MODEL NUCLEAR REACTORS. Malan, G. F.; Koen, B. V. (Univ. of Texas, Austin). Nucl. Sci. Eng.; 46: No. 3, 385-93(Dec 1971).

The application of a nonlinear programming technique for the calculation of the optimal control of a nuclear reactor with explicit inequality constraints applied to the controlled input is described. Accurate numerical solution of the reactor dynamics is emphasized and a number of numerical examples are presented which illustrate the general utility of the optimal control procedure. 17 references. (auth)

Kinetics

Refer also to abstracts 9329, 11337, and 11339.

11413 (AECL–3739) EFFECTIVENESS OF LATREP CALCULATIONS: A SURVEY AND DETAILED COMPARISON WITH EXPERIMENT. Griffiths, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1971. 94p. (CRNL–407). Dep. NTIS (U. S. Sales Only). AECL $2.50.

Data from which the accuracy of the LATREP code can be assessed are presented. Lattice parameters for a wide range of lattices measured in ZED-II and experimentally determined nuclide compositions for NPD fuel are compared with the corresponding LATREP predictions. The general conclusion is that LATREP is in as good agreement as could be expected from a code of this type. (auth)

11414 LINEAR EXTRAPOLATION DISTANCES FOR CENTRALLY AND ECCENTRICALLY LOCATED CONTROL RODS. Borak, Fahir (New York Univ., N. Y.). Nucl. Technol.; 13: No. 1, 20-8(Jan 1972).

Using one group diffusion theory, linear extrapolation distances for centrally and eccentrically located black control rods in cylindrical geometries were determined by the pulsed neutron method. It is found that for a given radius control rod, the extrapolation distance increases with increasing moderator radius. Linear extrapolation distance is also found to increase with eccentrical location of control rods. In general, the values of the extrapolation distances determined for central rods in diffusion theory, in the range of moderator radii studied, are higher in value by 10–100% than the classical values based on the theoretical calculations of Davison and Zaretsky. The values of the linear extrapolation distances for eccentric control rods, in the range of the moderator radii studied, are also higher than the central control rod extrapolation distances up to a factor of 6, the increase depending on the location of the control rods. (13 references) (auth)

11415 NEW SOLUTION OF THE POINT KINETICS EQUATIONS. da Nobrega, J. A. W. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 46: No. 3, 366-75(Dec 1971).

A technique based on the Padé approximations is applied to the solution of the point kinetics equations. The method consists of treating explicitly the roots of the inhour formula which would make the Padé approximations inaccurate. Also, an analytic method is developed which permits a fast inversion of polynomials of the point kinetics matrix and has direct applicability to the Padé approximations. Results are presented for several cases using various options of the method. It is concluded that the technique provides a fast and accurate computational method for the point kinetics equations. 21 references. (auth)

11416 FOUR-GROUP INTEGRAL ALGORITHM FOR CALCULATION OF CRITICALITY OF HETEROGENEOUS URANIUM–WATER REACTORS. Apostolov, T. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 20: 185-99(1971). (In Russian).

The four-group method for calculation of heterogeneous uranium-water reactors is considered on the basis of the four-group integral algorithm created for calculation of the criticality. The algorithm is realized by means of an algorithmic language ALGOL-60. The results obtained from calculations and comparisons with the experimental data show that in accuracy, fast-acting, and breadth of the region, this algorithm completely satisfies the best existing world standards. (13 references) (auth)

11417 ROOTS AND COEFFICIENTS FROM THE INTEGRAL SOLUTION OF THE REACTOR KINETIC EQUATIONS APPLICABLE TO ^{235}U FUELED, HEAVY WATER MODERATED REACTORS. Curdele, Joseph S.; Danofsky, Richard A. (Iowa State Univ., Ames). Nucl. Sci. Eng.; 46: No. 3, 425-7(Dec 1971).

The characteristic parameters necessary to describe the kinetic behavior of D_2O moderated reactors were calculated for various prompt-neutron lifetimes. Comparison is made of the reactor response to reactivity changes when evaluated using fast-fission and thermal-fission delayed-neutron-group constants combined with D_2O photoneutron constants. (auth)

11418 KINETIC BEHAVIOUR OF SIMPLE NEUTRONIC SYSTEMS WITH RANDOMLY FLUCTUATING PARAMETERS. Williams, M. M. R. (Queen Mary Coll., London). J. Nucl. Energy; 25: No. 11, 563-83(Nov 1971).

The problem of neutron density fluctuations in a nuclear reactor when the reactivity is a Gaussian, stationary random function was considered. Point model kinetic equations were employed and a range of situations studied by using no delayed neutrons; infinite delay time model; and zero prompt generation time model. In each case the mean value of the flux, arising from the random reactivity insertion, was found to be an increasing function of time. This led to the conclusion that, despite its zero mean, a random fluctuation caused positive reactivity feedback and could therefore lead to instability. Probability distributions for the resulting neutron densities were computed and shown to be non-Gaussian. The precise shape depended on the power spectral density of the input reactivity fluctuations. By making use of the exact solutions obtained from the above models, the accuracy of an approximation technique was assessed, based on closure methods, which proved useful for more complicated situations not amenable to exact solution. (auth) (UK)

Dynamics

Refer also to abstracts 9425 and 9446.

Experimental Applications

11419 EVALUATION OF NEUTRON SPECTRAL EFFECTS IN A PLUTONIUM-FUELED LATTICE BY FOIL ACTIVATION. Orestano, F. V.; Pistella, F. (CNEN, Rome). Nucl. Sci. Eng.; 46: No. 3, 376-84(Dec 1971).

The investigation of the neutron spectral effects in actual cell geometry in a plutonium-fueled lattice is the final step of a program undertaken at LFCR of CNEN on the investigation of the physics problems for the plutonium recycle in light water reactors. Spectral indices were measured by foil activation techniques, in the fuel pins and in the moderator, both in a uniform lattice and in the presence of a cross-shaped water gap; the presence of the water gap reduces the value of the index ^{239}Pu-fission/^{235}U fission by about 8%. The measured values were compared with the results of the design calculational methods as well as those of a more detailed method and agreement is good. In particular, it was found that the use of two thermal-energy groups (in a five-group scheme) is necessary to describe properly the effect of water gaps on the plutonium effective cross sections. The ^{239}Pu absorption rate was evaluated from the measured spectral indices by applying a previously tested correlation method; the presence of the water gap also reduces the ^{239}Pu absorption/^{235}U-fission-ratio by about 10%. (18 references) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 9072, 9078, 9079, 9082, 9084, 9095–9097, 9101, 9141, 9173, 9218, 9219, 9336, 9416, 9430, 9701, 9707, 9840, 9843, 9851, 9855, 9867, 9890, 9906, and 9916.

11420 (BNWL–1597) ACOUSTIC EMISSION MONITORING FOR CONTINUOUS CRACK DETECTION IN NUCLEAR REACTOR PRESSURE BOUNDARIES. Hutton, P. H. (Battelle Pacific Northwest Labs., Richland, Wash.). Nov 1971. Contract AT(45-1)-1830. 40p. Dep. NTIS.

A program to develop application of acoustic emission techniques to reactor system integrity surveillance is reviewed. Capabilities resulting from this program include use of acoustic emission monitoring to detect and locate flaws in pressure vessels and piping during hydrostatic testing, flaw formation during welding, incipient fatigue failure points in metal structures and stress corrosion cracking in metals. Better definition of the acoustic emission signal and propagation was achieved, as well as development of specialized detection instrumentation and suitable techniques for data analysis (including real-time source location techniques). 23 references. (auth)

11421 IMPROVEMENTS IN NUCLEAR REACTOR INSTALLATIONS. Jones, Desmond Hector (to United Kingdom Atomic Energy Authority). British Patent 1,253,991. 17 Nov 1971. Filed 5 Apr 1968.

Reference is made to liquid cooled reactors wherein the fuel is contained in vertical tubes and a pond is provided above the reactor into which irradiated fuel can be withdrawn. In present construction in order to gain access to the top of the reactor the structure forming the bottom of the pond must be removed, involving the dismantling and subsequent reassembly of several hundred gland seals. An object of the system described is to simplify gaining access to the top of the reactor. The fuel can be withdrawn from the tubes into the pond through detachable tube extensions that sealably penetrate the bottom of the pond and are slidably sealed to the tubes. These sliding seals avoid the need for gland seals. The detachable extensions may be withdrawn from the tubes either with or without displacement of the pond bottom structure; in the former case the need to dismantle numerous gland seals is avoided, while in the latter case access to the top of the reactor may be gained under the pond bottom structure by removal of a group of the extensions. (UK)

11422 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF COATED PARTICLE FUEL FOR NUCLEAR REACTORS. Freck, David Vernon (to Central Electricity Generating Board). British Patent 1,253,636. 17 Nov 1971. Filed 20 Apr 1970.

Reference is made to the manufacture of fuel systems consisting of pyrolitic carbon coated fuel particles embedded in a graphite matrix, and the pre-irradiation testing thereof. In the method of testing described ^{226}Ra is incorporated in the fuel material and the particles are heated to at least 800°C while circulating an inert gas over them and checking this gas for the presence of ^{222}Rn. Although the testing may be done after manufacture it is convenient

to conduct the heating as a stage in manufacture, such as the final carbonization stage, normally at 800°C, or the degassing stage at 1800°C. The Ra may be incorporated as a mixture of stearate with Al stearate in the binders used in the manufacturing process. The amount of radium required is stated to be so small that there should be no risks if the ventilation is adequate. The apparatus described comprises a closed furnace for heating the particles, means for circulating the inert gas through the furnace and through a decay chamber fitted with a filter to collect solid radioactive radon daughters, and finally an α-particle counter. The quantity of Ra in the fuel may be measured by γ-spectroscopy. (UK)

11423 EMERGENCY NUCLEAR REACTOR SHUTDOWN SYSTEMS. Bennett, John Charles (to Atomic Power Constructions Ltd.). British Patent 1,255,927. 1 Dec 1971. Filed 30 Nov 1967.

A secondary shut down system is described that functions independently of the normal control rods, and is associated with the bottom face of the reactor and this is less likely to be affected by the fault preventing control rod shutdown. One or more upright U tubes are employed, one of the limbs of each U tube extending into the core from the bottom face, the other limb being external of the core and connected to a reservoir. The tube contains a column of spheres of neutron absorbing material and a second column of spheres of non-neutron absorbing material. In the non-shut down condition the second column is located at least partly in the reservoir and all the spheres of the first column are external to the core. Means are provided for releasing the spheres from the reservoir, the arrangement being such that while held in the reservoir the spheres of the second column do not exert any force on those of the first column, but once released move into the tube to force the spheres of the first column to move upwards into the extension within the core and be retained there by the weight of the spheres of the second column. The release means for the spheres may be a source of fluid pressure. Decelerating means may be provided for the spheres; this may comprise a fluid flow constriction at the end of the limb extending into the core. One-way valve arrangements may also be incorporated. (UK)

11424 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL. Williams, Neville Ronald; Lloyd, Henry (to United Kingdom Atomic Energy Authority). British Patent 1,256,033. 8 Dec 1971. Filed 6 Aug 1969.

Reference is made to the production of coated particle nuclear fuels, dispersed in a graphite matrix. In the pressure compacting process normally used there is a considerable risk of cracking of the particle coating, when pressures of the order of 2000 lb/sq in. are employed to obtain the required fuel density. In the process described the coated fuel particles are overcoated with matrix material, mixed with a binder in a die to form a loosely compacted mass, and then ram-compressed in the die while subjected to vibration, to form a compacted artefact. It was found that pressures of the order of 1000 lb/sq in. sufficed to achieve the desired density. The binder may be cured while the compact is in the die and subsequently removed, and it may consist of a thermosetting phenolformaldehyde resin. The compacted artefact may be heated first to a temperature to effect curing of the binder (70° to 200°C), then to a temperature to carbonize the binder (~850°C), and finally under vacuum conditions to cause outgassing of the cured artefact (~1850°C). (UK)

11425 FISSION PRODUCT RETAINING FUEL. Graham, Leslie Wilfred; Voice, Eric Handley; Brinkmann, Heinz Ulrich (to United Kingdom Atomic Energy Authority). British Patent 1,256,110. 8 Dec 1971. Filed 5 Nov 1969.

Reference is made to the production of coated particle nuclear fuel. Processes used have involved the application of several coatings at different temperatures, resulting in a complicated pattern of internal stresses with resulting detriment to fuel performance and complication of the production process. In the process described a temperature range (1550° to 1650°C) is selected for deposition of the normal pyrolytic carbon layers and also within that range the required other layers, such as SiC. In the case of SiC a desirable structure for fission product retention may be obtained by pyrolytic decomposition of methyltrichlorosilane vapor in the presence of H_2 at about 1630°C, UO_2 particles can be obtained with a combination of pyrolytically deposited coating, including differently structured pyrocarbon layers, by selecting as the C source butane gas of commerical purity, mixed with CO, Ar or H_2 as diluent, and pyrolysing at a substantially uniform temperature, the required different characteristics of the pyrocarbon layers being achieved by variation in the gas flow conditions. An interlayer of SiC is deposited between the pyrocarbon layers, and the deposition temperature of this interlayer, from methyltrichlorosilane, then becomes the governing temperature of the process. Examples of application of the process are given. Fluidization techniques may be adopted. (UK)

GENERAL

11426 (ACRH-1000-291) POLYPEPTIDES OF HUMAN SERUM LIPOPROTEIN AND THEIR CLINICAL SIGNIFICANCE. Scanu, Angelo M. (Chicago Univ., Ill. Pritzker School of Medicine. Argonne Cancer Research Hospital, Chicago, Ill.). [1971]. Contract AT(11-1)-69. 16p. (CONF-711128-1). Dep. NTIS.
From seventeenth applied seminar on the clinical pathology of the lipids; Washington, D. C. (12 Nov 1971).

11427 (ANL-Trans-906) SPEED OF ULTRASOUND, COMPRESSIBILITY OF LIQUID METALS AND THEIR RELATIONSHIP WITH VARIOUS PHYSICAL PROPERTIES. Filipov, S. I.; Kazakov, N. B.; Pronin, L. A. Translated for Argonne National Lab., Ill., from Izv. Vyssh. Ucheb. Zaved., Chern. Met.; 9: No. 3, 8-14 (1966). 11p. Dep. NTIS.

11428 (BDX-613-433) SPIRAL WRAP: A TECHNIQUE FOR FABRICATING THICK-WALL CARBON COMPOSITES. Steele, J. W.; McCoy, J. C.; Frye, E. R. (Bendix Corp., Kansas City, Mo.). Sep 1971. Contract AT(29-1)-613. 56p. Dep. NTIS.

11429 (BDX-613-528) CHARACTERIZATION OF FILM ADHESIVES. Final Report. Atkinson, K. C. (Bendix Corp., Kansas City, Mo.). Oct 1971. Contract AT(29-1)-613. 75p. Dep. NTIS.

11430 (BDX-613-577) STRAIN HARDENING EXPONENT FOR 17-4 PH STAINLESS STEEL. Mulkey, J. R. (Bendix Corp., Kansas City, Mo.). Oct 1971. Contract AT(29-1)-613. 34p. Dep. NTIS.

11431 (BDX-613-578) VOLATILE LOSS IN POLYSTYRENE FOAM. Roebuck, C. E.; Fossey, D. J. (Bendix Corp., Kansas City, Mo.). Oct 1971. Contract AT(29-1)-613. 102p. Dep. NTIS.

11432 (BNL-16259) HYDROGEN FOR ENERGY TRANSPORT AND STORAGE IN SOLAR ENERGY SYSTEMS. Hoffman, Kenneth C.; Winsche, Warren E. (Brookhaven National Lab., Upton, N. Y.). [1970]. 6p. (CONF-711035-1). Dep. NTIS.
From third conference on large scale solar energy conversion for terrestrial use; Newark, Del. (9 Oct 1971).

11433 (CONF-710909-3) GENERAL SURVEY OF ELECTRON SPECTROSCOPY. Carlson, Thomas A. (Oak Ridge National Lab., Tenn.). [1971]. 45p. Dep. NTIS.
From International conference on electron spectroscopy; Pacific Grove, Calif. (7 Sep 1971).

11434 (CONF-711203-1) BIOCHEMICAL INDICATORS OF ENVIRONMENTAL POLLUTION. Goldstein, Gerald (Oak Ridge National Lab., Tenn.). [1971]. 39p. Dep. NTIS.
From American Association for the Advancement of Science annual meeting; Philadelphia, Pa. (26 Dec 1971).

11435 (COO-1140-200) VAPORIZATION AND THERMODYNAMICS OF RARE EARTH SULFIDES. PART I: VAPORIZATION STUDY OF GADOLINIUM SULFIDES. PART II: ISOMOLECULAR SULFUR EXCHANGE REACTIONS OF RARE EARTH SULFIDES. Wu, Richard Li-Chuan (Kansas Univ., Lawrence. Dept. of Chemistry). 8 Jul 1971. Contract AT(11-1)-1140. 521p. Dep. NTIS.
Thesis.

11436 (COO-1198-861) LONG-RANGE FORCES IN SODIUM CHLORIDE. Marshall, Russell Frank (Illinois Univ., Urbana). Oct 1971. Contract AT(11-1)-1198. 87p. Dep. NTIS.
Thesis.

11437 (COO-1469-194) SYNCHRONIZATION SYSTEM FOR A TELEVISION BANDWIDTH COMPRESSION SCHEME. Carr, Edward Ellis (Illinois Univ., Urbana. Dept. of Computer Science). Oct 1971. Contract AT(11-1)-1469. 20p. (UIUCDCS-R-71-483). Dep. NTIS.
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11438 (COO-1469-195) COEFFICIENT GENERATOR AND CURSOR FOR THE STEREOMATRIX 3-D DISPLAY SYSTEM. Cheng, Richard Thien-Ren (Illinois Univ., Urbana. Dept. of Computer Science). Oct 1971. Contract AT(11-1)-1469. 98p. (UIUCDCS-R-71-484). Dep. NTIS.
Thesis.

11439 (COO-1469-197) ALPHECHON: EVALUATION OF A DEVELOPMENTAL VIDEO STORAGE TUBE. Kodimer, Dennis A. (Illinois Univ., Urbana. Dept. of Computer Science). Sep 1971. Contract AT(11-1)-1469. 45p. Dep. NTIS.

11440 (COO-1591-18) IMPURITY EFFECTS ON THE CREEP OF POLYCRYSTALLINE MAGNESIUM AND ALUMINUM OXIDES AT ELEVATED TEMPERATURES. Technical Progress Report, December 19, 1970-December 18, 1971. Gordon, Ronald S. (Utah Univ., Salt Lake City. Div. of Materials Science and Engineering). Dec 1971. Contract AT(11-1)-1591. 49p. (UTEC-MSE-71-230). Dep. NTIS.

11441 (COO-1668-21) PROGRESS REPORT [ON INTESTINAL CALCIUM TRANSPORT MECHANISM], SEPTEMBER 1, 1970-SEPTEMBER 1, 1971. [DeLuca, Hector F.] (Wisconsin Univ., Madison). Contract AT(11-1)-1668. 7p. Dep. NTIS.

11442 (COO-2008-5) SELF-DIFFUSION OF Ag^+ AND Na^+ IN MOLTEN $Ca(NO_3)_2$-KNO_3. Welch, B. J.; Angell, C. A. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Nov 1970. Contract AT(11-1)-2008. 30p. Dep. NTIS.

11443 (COO-2166-1) A STUDY OF GRAIN BOUNDARY SEGREGATION USING THE AUGER ELECTRON EMISSION TECHNIQUE. [Annual Progress Report, 1971]. Stein, Dale F. (Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering). Contract AT(11-1)-2166. 8p. Dep. NTIS.

11444 (INP-767) MOESSBAUER EFFECT ANALYSIS OF Fe-Mn NODULES FROM VARIOUS PACIFIC OCEAN LOCATIONS. Hrynkiewicz, A. Z.; Pustowka, A. J.; Sawicka, B. D.; Sawicki, J. A. (Institute of Nuclear Physics, Krakow (Poland)). May 1971. 14p. Dep. NTIS (U. S. Sales Only).

11445 (IS-2742) EVALUATION OF INTEGRALS ORIGINATING FROM THE THEORY OF DENDRITIC GROWTH. Yost, F. G. (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 17p. Dep. NTIS.

11446 (JINR-P4-6068) MAGNETORESISTIVITY OF DILUTE MAGNETIC ALLOYS. Kozarzewshi, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

11447 (KFK-1425) LIST OF SCIENTIFIC PUBLICATIONS OF THE KARLSRUHE NUCLEAR RESEARCH CENTER FOR THE YEAR 1970. (Kernforschungszentrum, Karlsruhe (West Germany)). [1971]. 43p. (In German). Dep. NTIS (U. S. Sales Only).

11448 (KFK-1428) STABILITY AND CONVERGENCE OF NONLINEAR DIFFERENCE OPERATORS IN INITIAL VALUE PROBLEMS. Kinnebrock, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jun 1971. 56p. (In German). Dep. NTIS (U. S. Sales Only).

11449 (LA-4760) NEW MODEL OF FLUIDS. Kerley, Gerald I. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 23p. Dep. NTIS.

11450 (LA-4778) PHYSICAL METHODS APPLICABLE TO THE DETECTION OF TRICHINELLA SPIRALIS IN PORK. Seagrave, John D.; Prine, James R. (Los Alamos Scientific Lab., N. Mex.). Nov 1971. Contract W-7405-eng-36. 31p. Dep. NTIS.

11451 (LA-4796) GRAPHICAL REPRESENTATION OF TWO-VARIABLE DATA. Nagy III, Nicholas J. (Los Alamos Scientific Lab., N. Mex.). Nov 1971. Contract W-7405-eng-36. 71p. Dep. NTIS.

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